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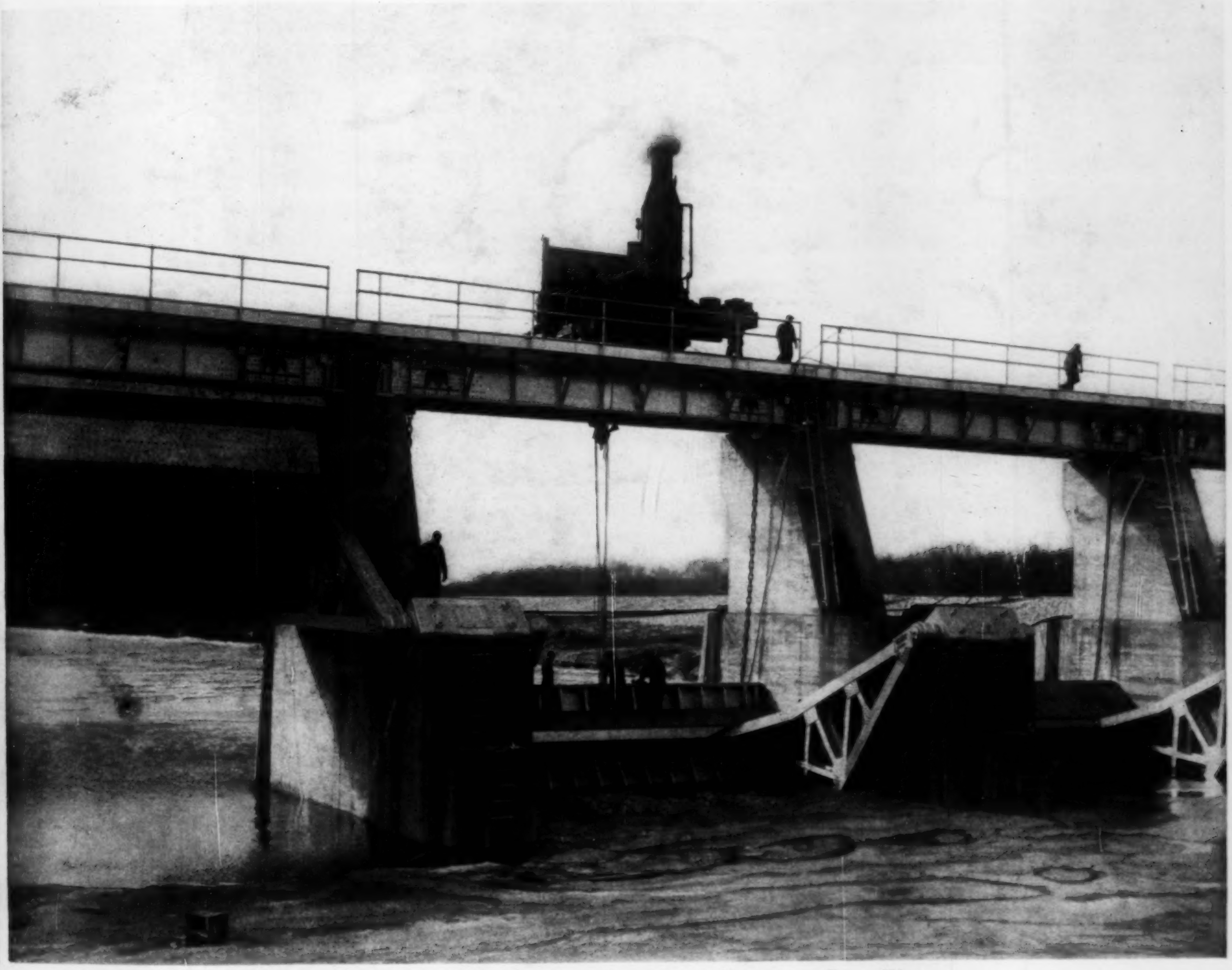
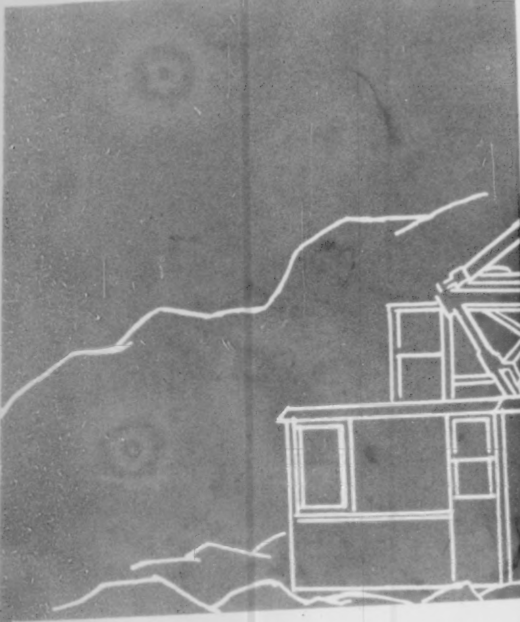


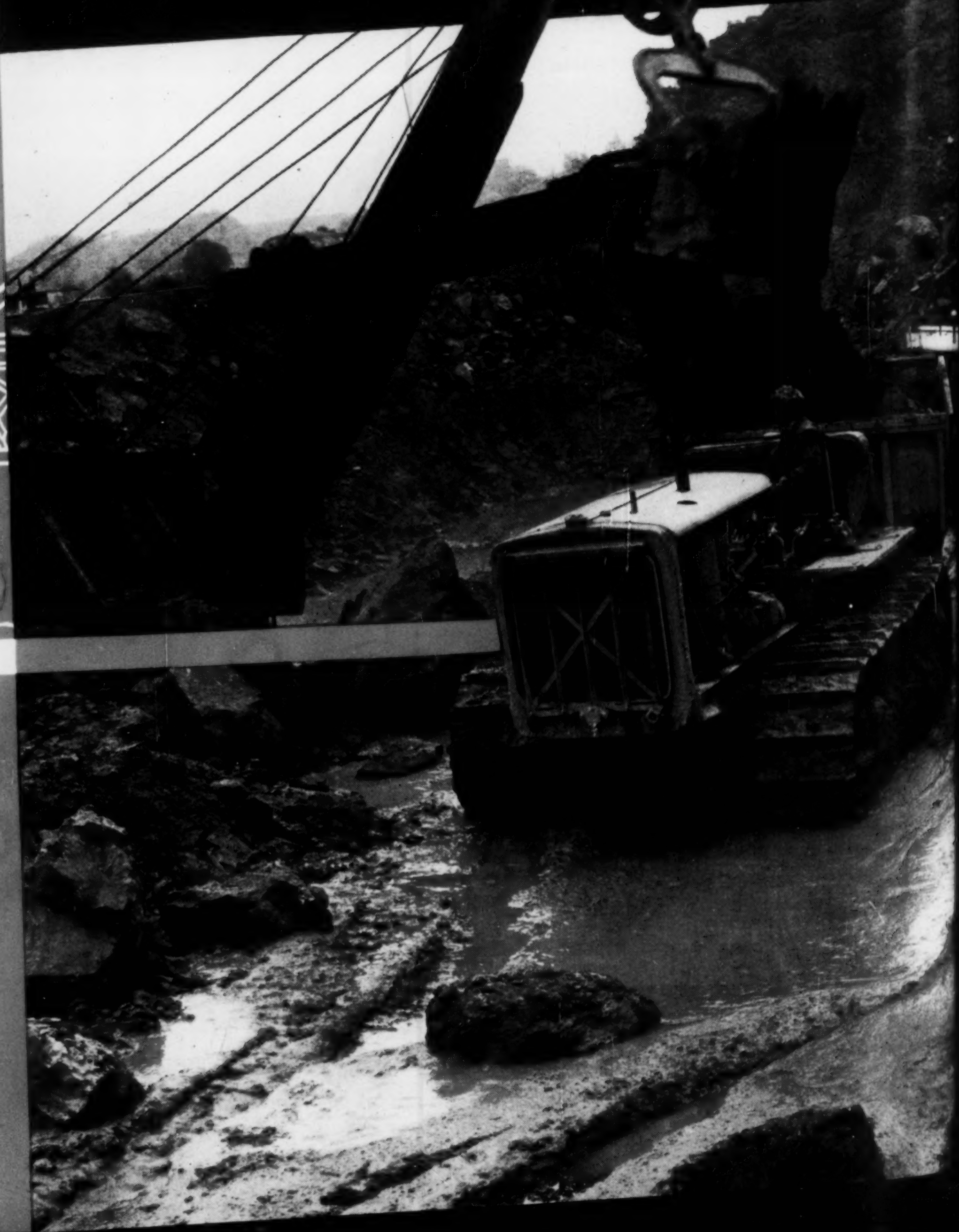
Raising 35- by 15-Ft Tainter Gates near Fountain City, Wis.
These Huge Gates Are a Feature of the U. S. Canalization Improvements on the Upper Mississippi

Volume 6 AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 *Number 2*

FEBRUARY 1936

FIRST—AND WHY!





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Victoria Hydro-Electric Development

Plant in Northern Michigan Involves Interesting Design and Construction Features

By E. L. Chandler
Member American Society of Civil Engineers
Chief Engineer, Chattanooga Flood Protection District, Chattanooga, Tenn.

Although perhaps considered small as compared with many water power developments in this country, the Victoria project involves unusual design details in its power plant and especially in the multiple-arch section of the dam. By adjusting the position of the battered piers, the springing lines of the arches were made parallel and the construction greatly simplified. An interesting provision was made to reduce ice thrust against this part of the dam by piping air over the water face. Subsequent experience, however, showed clearly that this measure for ice control was unnecessarily elaborate. From a construction viewpoint the extensive use of compressed air furnished by an old hydraulic compressor, a relic of the prosperous mining days of the region, is notable. These and other instructive experiences lend unusual interest to the successful work so well described in this paper.

The Victoria plant, first unit of a proposed extensive development of the hydro-electric power possibilities of the Ontonagon River, in northern Michigan, was brought to completion in 1931. It consists of a dam, a wood-stave pipe line nearly 6,400 ft long, and a power house containing two units of 7,500-kva capacity. It is on property once belonging to the Victoria Mining Company, about 15 miles south of the town of Ontonagon, Mich., on Lake Superior. Power is supplied to Ontonagon and to the Houghton County Light and Power Company, 50 miles to the east, for copper mining and other purposes.

The total head developed averages 208 ft, including a natural fall of nearly 100 ft from the dam to the power house, which is located at the headwater of what will be the next development below.

A favorable location for the dam was found in a rock gorge just downstream from the Victoria rapids, where the river flows in an easterly direction. The south (right) side of the gorge rises 90 ft almost perpendicularly from the bed of the stream, while the north bank, after rising abruptly about 50 ft, slopes back more gradually (Fig. 1).

In general, the dam consists of a concrete structure flanked at the ends by earth embankments. The principal feature is a section composed of four inclined arches supported on piers built on approximately 75-ft centers. This is really an arched multiple-arch structure; the piers converge slightly downstream, although no consideration was given to that condition in working out the design for stability. The convergence was introduced to simplify the construction work.

Adjoining the multiple-arch section on the south is a hollow-deck, reinforced concrete spillway of four 22-ft bays, each surmounted by a radial gate to hold the pond level at 12 ft above the fixed crest. North of the arch section is the intake structure, from which flow is controlled by a roller-bearing, vertical-lift gate (Fig. 1).

Extending north from the intake structure is an earth embankment with a concrete core wall. South of the spillway is a small embankment built without a core wall, it being intended that in the event of unexpectedly severe flooding, this earthwork will provide an extra factor of safety for the dam proper by washing out. The total length of the dam is approximately 700 ft. All the concrete is founded on ledge rock except for part of the north embankment core wall, which is trenched into the clay overburden.

SIMPLIFYING PIERS AND ARCHES

In the design a careful study was made of the relative merits of various types of structure when adapted to the site. An inclined multiple-arch dam was finally adopted, although there was little dependable precedent for the design and construction of multiple arches of such dimensions. Footings for the piers were carried at least 3 ft into solid rock after the removal of overburden and unstable rock. At pond level the piers are 8 ft 10 in. long. With the downstream end of the pier battered at the rate of 2 in. per ft and the upstream nose inclined at an angle of 45° 45′ from the horizontal, the largest pier is 138 ft 11 in. long at the footing, with a height of 114 ft from the top of the footing to pond level, and a total height of 119 ft to the level of the walk across the top of the arches. This pier is 9 ft thick at the base and 5 ft thick at the top.

The sides of the piers batter uniformly, and each is a plane surface except for a rib added at the downstream end both for stability and for architectural effect. On the highest pier, the rib is 9 ft along the pier by 14 ft transversely, measured at footing elevation, and diminishes to 3 ft 6 in. by 6 ft at pond elevation.

In laying out the axes of the piers, the convergence was made such that, combined with the batter of the piers, the springing lines of any arch would be parallel. The arch thickness at the center of the bay varies uniformly from 4 ft 6 in. at the bottom of the gorge to 2 ft 6 in. at the crest of the dam. Thus, each arch has a cylindrical intrados and a conical extrados. The constant radius for the intrados is 34 ft 9 in., with a distance of 68 ft $5^{1}/_{4}$ in. between springing lines, giving an included angle of 160 deg. The simplicity of form work thus obtained was of substantial advantage in construction as later described more in detail.

GROUTING TO PROVIDE WATERTIGHTNESS

A concrete cut-off was notched into the rock along the upstream line of the concrete structures, being carried at least 10 ft into the solid ledge. The geology of the region is interesting. At the dam site the ledge rock is a rather soft, young sandstone, laid down in strata varying in thickness from a few inches up to several feet and interlaid with thin clay-filled seams. The dip is to the southwest. The gorge is narrower and deeper at the site selected than at any other point in the vicinity, and gives the impression of faulting in the rock structure. Such is not the case, however, as there are definite indications that it is entirely a water-worn formation.

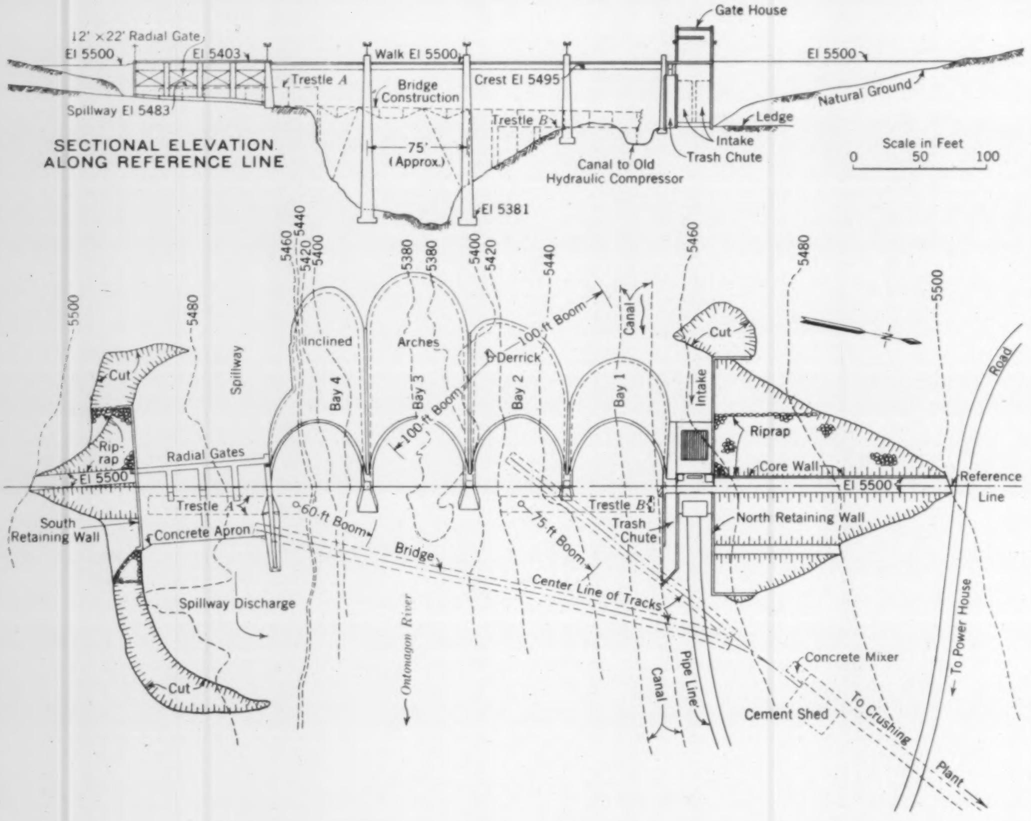

12' × 22' Radial Gate
El 5500
El 5403
Walk El 5500
Gate House
El 5500
Trestle A
Bridge Construction
Crest El 5495
Natural Ground
Spillway El 5483
Trestle B
Ledge
Intake
Trash Chute
SECTIONAL ELEVATION ALONG REFERENCE LINE
75' (Approx.)
Canal to Old Hydraulic Compressor
Scale in Feet
0
50
100
El 5381
5500
5480
5460
5440
5420
5400
5380
5380
5400
5420
5440
5460
5480
5500
Cut
Spillway
Inclined
Arches
100 ft Boom
Derrick
Canal
Cut
Intake
Road
Bay 4
Bay 3
Bay 2
Bay 1
100 ft Boom
Riprap
Rip-rap
El 5500
Radial Gates
Core Wall
El 5500
Reference Line
Trestle A
60 ft Boom
Trestle B
Trash Chute
North Retaining Wall
South Retaining Wall
Concrete Apron
75 ft Boom
Bridge
Center Line of Tracks
Spillway Discharge
Ontonagon River
Canal
Pipe Line
Concrete Mixer
To Power House
Cut
Cement Shed
To Crushing Plant

FIG. 1. PLAN AND ELEVATION OF VICTORIA DAM
Elevations Are Referred to an Arbitrary Datum; Contours Indicate Original Topography

Owing to the seamy character of the rock, elimination of serious seepage was a problem requiring careful consideration. It was further complicated by the presence of pot holes varying greatly in size. The largest, 22 ft in diameter and about the same in depth, was below the bed of the river at the pier between bays Nos. 2 and 3.

Results obtained fully justified the program of grouting employed for sealing the formation. Under the pier footings holes to a depth of 20 ft were drilled at 25-ft intervals, and neat grout was forced in at a pressure of 117 lb per sq in. This was for the primary purpose of assuring solidity of the pier foundations. Along the entire upstream line of the concrete structure, 2-in. holes were drilled at intervals of 10 ft to depths of from 20 to 30 ft. After grout had been forced into these holes under the same pressure, intermediate holes were drilled and grouted. Where the second holes did not seal the rock tightly, still others were drilled and grouted. A clay blanket was spread over the bottom of the gorge upstream from the dam as a further precaution against seepage. The accumulated total amount of leakage, after more than four years of operation, was found not to exceed 1 cu ft per sec.

Protection for the dam against the thrust of ice was considered to be another very real problem in the climate of northern Michigan. For this purpose, a rather elaborate system of piping was installed to discharge compressed air through orifices at frequent intervals around each arch at a depth of 12 ft below pond level, and along the crest in the spillway. In practice, considerable difficulty was experienced, due to freezing in the pipes, and the installation was simplified. It was found that sufficient protection was afforded by forcing air through a single $^1/_2$-in. pipe along the upstream face of each pier, discharging at a point about 10 ft below the surface.

WOODEN STAVE PIPE LINE

The 10-ft-diameter pipe line connecting the dam and power house was necessarily located on steep side-hill slopes for much of its length. A large part of the overburden of the region is a heavy red clay, which appears hard and solid when dry and freshly exposed but is found to be extremely slippery and unstable when subjected to moisture. The design for the pipe line was given much consideration before it was decided to build it as an entirely exposed structure, rather than to cover it in part or in entirety.

Redwood stave pipe was adopted for the line up to a head of 120 ft; this included all but the part next to the power house, 300 ft long, which was of steel. Curvature in the alignment, both horizontal and vertical, was restricted to radii of not less than 600 ft. Reinforced concrete saddles were spaced at intervals of 10 ft, each comprised of a foundation sill and, bearing on the sill, the saddle proper, which is composed of two identical concrete castings. A permanent road surfaced with crushed rock was built along the downhill side of the pipe line to afford a means of quick access in case of fire or emergency repairs, and as a part of the park system developed by the Copper District Power Company.

SOME CONSTRUCTION FEATURES

As the nearest railroad siding was at Rockland, hauling of all equipment and purchased supplies for distances of from four to five miles was required, and this presented a considerable problem in transportation. The existing road as far as the Victoria mine had a substantial base as the result of work done many years ago by the Victoria Mining Company. However, grades as steep as 17 per cent were encountered, and the road crossed the Ontonagon River on an old steel truss bridge which had been designed for a loading of 14 tons but which had been severely damaged by an ice jam.

When moving construction equipment to the job, it was possible for a steam shovel and two gasoline-operated draglines to ford the river at low stage instead of crossing the bridge. The general hauling involved loads ranging up to 37.5 tons, that being the weight of each of the generator rotors.

Most of the miscellaneous material and equipment was hauled by truck. For the main substation transformers and the rotors, a trailer weighing 17.5 tons was used. The old bridge was reinforced by timber stringers under the steel floor system, supported on timber bents bearing on the river bottom. Power for hauling the rotors consisted of a caterpillar-mounted truck and two 10-ton caterpillar-tread tractors. On the steepest grades it became necessary to double the pull of one of the tractors by rigging a snatch block on the trailer and anchoring a cable to suitable trees along the way.

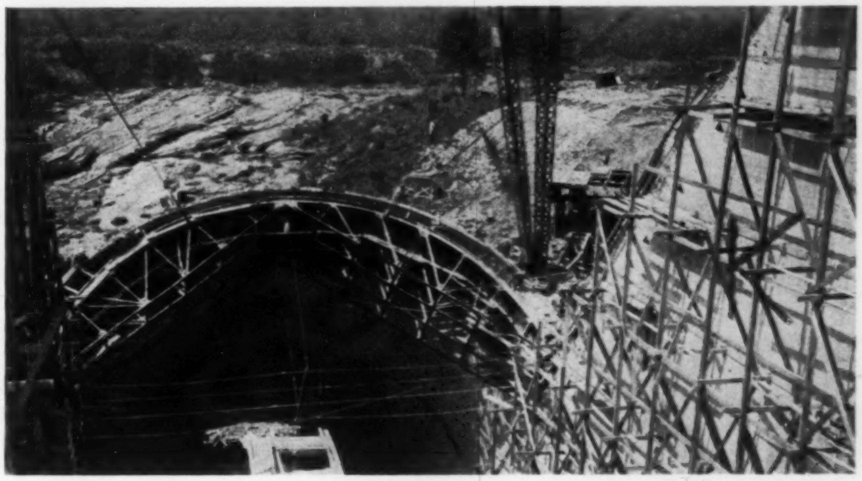
Access to the power house was over a new road, built as part of the general contract, on heavy descending grades. For the heaviest loads the two tractors were hitched behind the trailer to serve for braking.

Most of the sand for concrete aggregate was shipped by rail to Rockland, although a small quantity of suitable material was procured from the river bed near the power house, and some was reclaimed from the tailings of an old stamp mill about 1,000 ft downstream from the dam. Coarse aggregate was crushed from local rock in a plant set up near the dam site. All lumber for construction purposes was sawed from native timber with portable mills at or near the site.

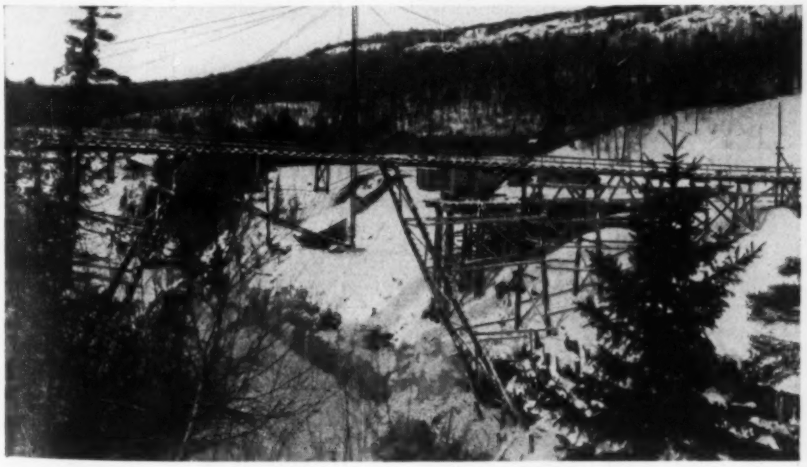
OLD AIR COMPRESSOR FOUND USEFUL

A widely known and spectacular old hydraulic air compressor of the Victoria Mining Company, about 600 ft downstream from the dam, turned out to be an exceedingly valuable adjunct to the construction equipment. Hydraulic compressors of any considerable size are rare on this continent. This one was put in service in 1906 as a power plant for copper-mining operations. Its original rated capacity was 4,000 hp under a pressure of 117 lb per sq in. No use had been made of the air since the mine closed in 1923.

By piping air from the old system to the dam site, an ever-ready supply of power was available for nearly every operation of construction from start to finish. Use was also made of the air-operated shops at the mine, where the old equipment was still in place and suitable for most of the drill sharpening, repairing, and other work incidental to construction.



Bay No. 3 Under Construction, Looking Upstream
Bottom of Arch Completed, Steel Arch Forms in Place, and Piers with Scaffolding at Sides

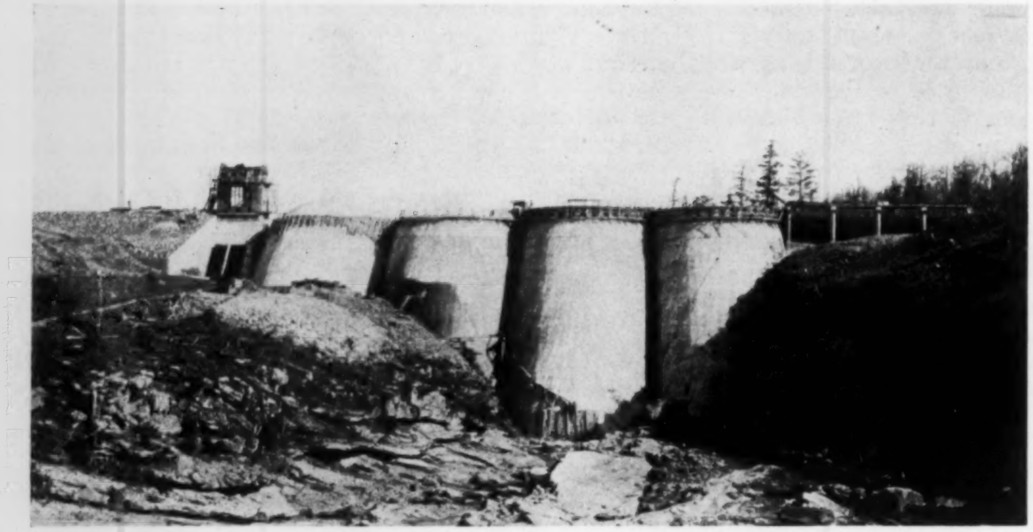


Preliminary Work Completed—View Looking Upstream
Bridge Across Gorge Gives Access to South Bank, at Left; 100-Ft Derrick Is in Place, Beyond

FEATURES OF PLANT LAYOUT

Owing to the danger of severe flooding in the gorge, and to the difficulty of access, it was determined to so arrange the construction layout that every piece of equipment used in the bottom could be readily lifted out in case of emergency. Furthermore, the south bank was inaccessible except by fording the river about a half mile above the dam during occasional low stages. It was therefore decided to build a temporary high-level bridge across the gorge just downstream from the dam and, in addition, to build a trestle on each bank on which traveling cranes could be operated. With the addition of a guy derrick located on the north bank near the upstream toe of the dam, it was possible to reach nearly all parts of the excavation and the concrete structure with one or another of these pieces of apparatus.

Such a plant made it possible to place concrete in the forms with very little chuting. The mixing plant was located on the north bank, as indicated in Fig. 1. Concrete was discharged from a 1-cu yd mixer into bottom-dump buckets on a platform car, which was hauled back and forth across the bridge, or along a track on the north bank, as the case might be, by a cable system operated by hoist engines. It was possible to spot a loaded bucket within reach of some one of the booms and thus to swing it into place for dumping directly



Structure Nearing Completion—Upstream Face

Intake at Left; Spillway at Right; in Center, Drainage Opening at Foundation Level Being Concreted While Flow Goes Through Spillway

into most of the forms. A general idea of the plant layout may be gained from Fig. 1, in both plan and elevation, and from a number of the photographs.

FORM WORK SIMPLIFIED

The principal piers were poured in lifts of 12 ft, with horizontal joints. Wooden forms were built in panels of convenient size for repeated setting. Near the top of each pour, bolts were placed, and the panels were so built that when they were raised to position for a new setting the studs lapped down on the concrete far enough to permit each unit to be bolted in place. The panels were easily raised by a small, hand-operated crab gin-pole handled from the top of successive lifts as required. Steel rods were used for form ties.

A scaffold was carried up the sides of the piers. By fastening the inside ends of the cross members to the bolts already mentioned in each 12-ft lift, it was possible to carry each scaffold up with only one set of vertical legs.

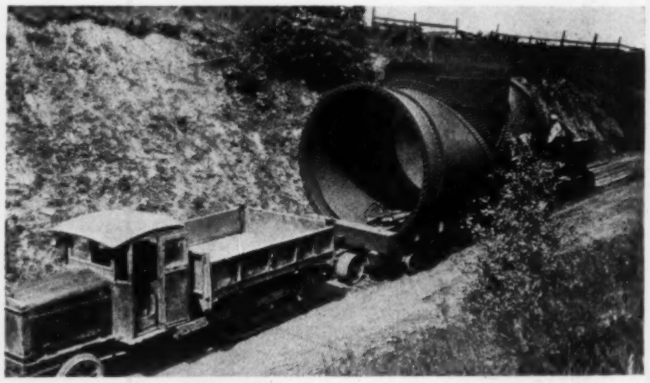
For the interior forms of the arches it was determined to use a movable steel unit suitable for a 15-ft section that could be readily reset for successive lifts. As will be seen in one of the photographs, there were four fabricated arch ribs. The ribs were assembled in place for the lowest section of arch, and the steel skin plates bolted in position. Each rib was pin connected at the crown and tied across at the springing line with a rod. Holes were shop punched through the skin plate to provide for form ties.

The fact that the springing lines of each arch were parallel with each other, greatly simplified the problem of interior forms. When the piers were built a series of pockets was formed in the sides at a fixed distance below the springing lines. Specially built steel brackets were placed in these pockets, and an I-beam was fastened along the tops of the brackets to serve as a support for the form ribs and to furnish a track along which the form could be moved as a unit to a new position.

When the form was assembled it was slightly below its true position. It was then accurately placed by screw jacks bearing on the I-beam track. When it was desired to shift the form, the jacks were removed, allowing the entire unit to draw away from the concrete and rest on the track, the ends of each rib being fitted with flat shoes. The form was pulled up along the track to its approximate new location and then jacked into correct position. Power for moving it was obtained from two hand crabs, one at each side of the bay, rigged with wire-rope cable and a system of sheave blocks. Enough brackets and track were used to permit one complete cycle of moving. While one 15-ft section of each was being built, the track on which the form had rested for the preceding section was being dismantled and transferred to a new setting higher up on the pier, in readiness to receive the form in its next position.

For the extrados, wooden forms were built in panels of sizes suitable for shifting by hand. After the steel forms had been set and the reinforcing steel placed, the outside forms were pulled up the incline into their proper positions. Forms for the irregular-shaped sections of arch at the bottoms of the bays and abutting on the sides of the gorge were built entirely of wood.

One detail that give rise to some difficulty was the shape of the joint between arch pours. At first a joint in a plane lying in a right section of the arch was sought as being most desirable. To secure this, it was necessary to build a bulkhead over the entire face of the joint, and it was then extremely difficult to procure satisfactory concrete at the crown of the arch. Therefore the shape was modified so that the joint did not lie in a plane surface but was warped from a right section, which extended from the springing lines approximately halfway toward the crown, to a nearly horizontal surface at the crown. No attempt was made to hold the central part of the joint to any exact dimensions, but, by omitting the bulkhead from that part of the face, it was possible to obtain sound concrete throughout. The amount of seepage through the arch joints has been negligible.



A Load for Mountain Roads

T-Section of Penstock on Special Trailer Drawn by Caterpillar-Tread Tractor

PLANNING SEQUENCE OF OPERATIONS

The fact that the design provided no permanent means for draining the pond below the level of the pipe-line intake complicated the problem of closure, but by taking advantage of an old canal leading to the hydraulic air compressor previously mentioned, it was possible to carry out a well-regulated program. Water for operating the old hydraulic compressor was impounded by a small dam across the river upstream from the main dam and was conducted to the compressor intake by a canal which followed the north bank of the river and passed through the site of bay No. 1, as indicated in Fig. 1. By taking advantage of periods of low flow, it was possible to pass the entire stream through the canal and thus permit the difficult work in the bottom of the gorge to be carried out under nearly dry conditions. Then, by diverting the water back into the natural river bed and passing it through a temporary opening provided for the purpose in the arch of bay No. 3, it was possible to work in bay No. 1.

Stave-Pipe Construction Follows Hillside
As Seen from Near Power House; Completed Saddles in Foreground

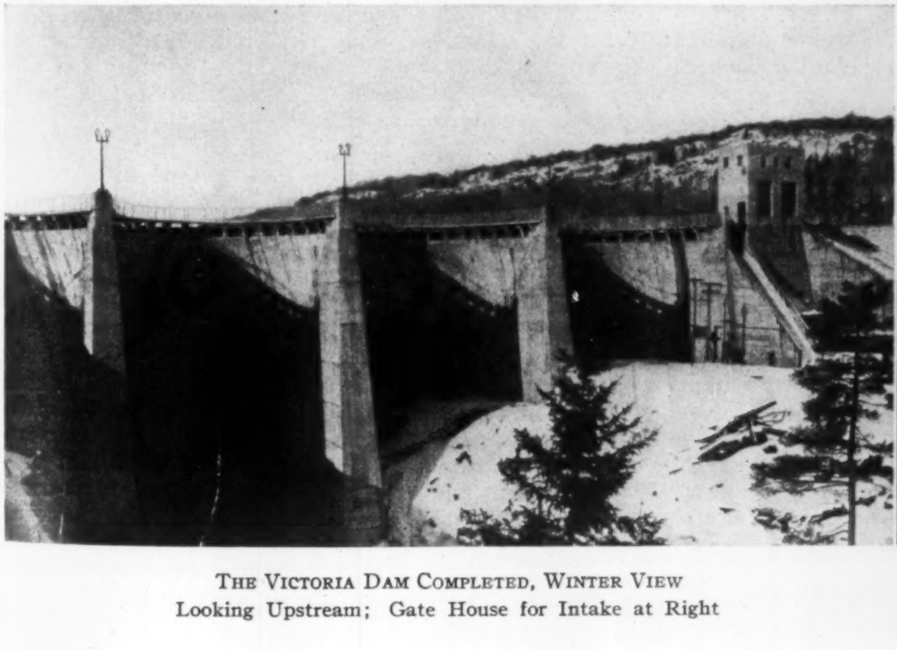
Before the final closure was accomplished, the water was again turned into the canal and through an opening in bay No. 1 until bay No. 3 had been closed. For the final step, the river was once more turned into the gorge and the arch of bay No. 1 was plugged while the pond was filling to canal level.

VICTORIA BUILDINGS FURNISH CAMP FACILITIES

Part of the necessary construction force was drawn from nearby villages, but it was also necessary to maintain a construction camp. Fortunately the contractor was able to arrange for the use of the buildings of the old mining village of Victoria for camp purposes. Rather extensive repairs were necessary but the results were very satisfactory. A general store and post office were reestablished; 150 men were quartered in the old hotel; 50 families lived in the houses of the village; blacksmith and machine shops were put in service; and the old mining company offices furnished quarters for both contractors and resident engineers.

Running water and electric lights were made available for most of the buildings. Here again the old hydraulic compressor proved of value, furnishing power for pumping water and for operating an electric generating plant. It also acted as a blower in a central heating plant for the offices and hotel, and provided refrigeration for the commissary by an arrangement for the suitable control of an air exhaust.

The Victoria plant is owned by the Copper District Power Company. It was designed, and its construction was supervised, by Holland, Ackerman and Holland, consulting engineers of Ann Arbor, Mich. Price Brothers Company of Dayton, Ohio, represented on the job by the writer, was the general contractor for all work except the transmission lines, having as associate contractor the R. E. Townsend Corporation of Ann Arbor.



The Victoria Dam Completed, Winter View
Looking Upstream; Gate House for Intake at Right

Power House Penstock and Surge Tank Seen from the River

No Maps in a Mapping Age

Conservation and Utilization of Vast Potential Wealth Is Accordingly Crippled

By William Bowie
Member American Society of Civil Engineers
Chief, Division of Geodesy, Coast and Geodetic Survey, Washington, D.C.

Among informed Americans there is ample familiarity with our national delinquency with regard to mapping and surveying. This has also been recognized by the Society in repeatedly advising government officials and lending the weight of its influence toward rectifying the present glaring deficiencies. Dr. Bowie has consistently emphasized these deplorable conditions, but in the present article he approaches the problem rather from an economic angle. Rich as we are beyond all nations, he reminds us, even so we cannot afford to squander our resources at the present rate. He instances water supply, mineral and agricultural resources, and road planning to show that enlarged mapping is an indispensable prerequisite for national development. The time is ripe, he emphasizes, for America to show as much purposeful interest in rational conservation as it has exhibited energy during the past in omnivorous consumption of its natural wealth. His arguments are forceful and his suggestions for an expanded mapping program must commend themselves as logical and practicable.

Today, every one is map conscious. It makes no difference whether he is traveling by automobile from one town to another, engaging in flood prevention work on rivers, laying out routes for highways, or working on prevention of soil erosion, utilization of land, and development of forests. Whatever his interest may be, he wants a map. In many cases the only map that he can get is a rather crude affair. In general, it is not accurate in position, distance, direction, or elevation, nor does it show the slope of the terrain.

To be useful a map should be a graphic representation of a part of the earth's surface. It should have a high degree of accuracy in the plotting of its details and show all the natural and artificial features that can be used in planning and in the execution of plans.

This country is very poorly mapped. In fact, it is one of the most backward in this particular of all the highly organized countries of the world. Why should this be so? There are probably many explanations, but the principal one is that we have been rich enough to survive the handicap of inadequate mapping. Our people have been blessed with a great wealth of natural resources and vast tracts of land; speed has been our god. When we plan a project, we want the dirt to fly today, or at the latest next week. Suppose promoters are told that a better job can be done if a map is made first; they are disgusted to learn it may be a month or more before an accurate topographic map can be produced, one that will show every feature of the area to be developed.

RICHES BEYOND MEASURE

We should realize that the present generation has inherited this country from its ancestors. As wise inheritors we should make an inventory of this wonderful patrimony. What has been handed down to us consists of three million square miles of land with soil of various degrees of fertility, an untold wealth of forests, rivers, streams and underground waters, and mineral resources of all kinds including oil, gas, and coal. These are the essentials for maintaining human life and for providing means of producing and distributing needed goods.

We have little knowledge of the potential wealth of America. We do not know the quality of the soil except for a part of our area. We do not know exactly what we have in our public and private forests. As for oil and coal, we have had all kinds of estimates for the last fifty or more years, first telling us that the supplies were limitless and then stating that in a very few years these supplies would be exhausted at the current rate of consumption. These are merely guesses—no one knows. No complete survey of the natural resources of this country has ever been made. There is no more urgent problem before the American people today than to find out just what we have, where it is, and whether it can be utilized. Then plans can be made for the use of our inheritance.

These plans should be rational rather than wasteful. They should not be designed to follow our long-standing practice of tearing out of the ground in a few years every thing that is there. We must, of course, use those parts of our resources that are necessary to our existence, but we should strive to hand down to the next generation our inheritance as little impaired as possible.

WATER ALSO CAN BE SQUANDERED

So far as we know, there is only one natural resource that is inexhaustible, and that is earth—rock, sand, and gravel. The amounts of these, of course, are fixed, but they exist in such vast quantities that we can count upon their supplying the needs of man for building structures of various kinds, including highways, for an indefinite future.

It may be claimed that the waters of our rivers are also inexhaustible. I gravely question this. While we do have rivers that have been flowing at a more or less constant rate since the first colonist came to this country, yet these rivers are being impaired. The marshes at their heads that supply a continuous flow of water are being drained. Natural grass and forests are being removed from drainage areas. This means that the water falling as rain rushes down the slopes, carrying vast quantities of soil and debris that fill up the river beds, causing disastrous floods. Who knows but that eventually, with practically all the land denuded of natural vegetation, the rivers will be merely channels, gorged at times with storm waters but practically dry between storms.

If the waters of our rivers and streams could be conserved by saving the swamps and marshes that head them and by retaining the vegetative cover in order that rain water may drain to the rivers gradually, they would remain a constant source of power. But without planning for the use of water, without conserving and protecting rivers and streams, we may expect in a comparatively short time to see this potential wealth definitely depleted.

For generations soil in this country was assumed to be inexhaustible. But assuredly it is not. We have been most wasteful of our agricultural land. We have let quantities of it wash away and we have depleted the fertility of other parts by stupid agricultural procedure.

One very clear case of the wasteful use of land comes to my mind. Some years ago I was working at a triangulation station in Minnesota in the Red River Valley, at one time one of the most fertile parts of our country. A farmer in an adjoining field was plowing in wheat stubble. I asked him what he intended planting in that field. He replied that he would put it back in wheat. Upon inquiry, I learned that he had already had that field in wheat for five consecutive years. I remarked that he was destroying the fertility of his soil and that shortly he would not be able to raise a crop that would repay him for his labor. He replied that he did not care, that he was a renter, and that when he could not make a living on that farm he would move to another one.

In that same wonderful wheat region, or what used to be a wonderful wheat region, I have seen great piles of stable manure allowed to dry. Then in mid-summer matches would be put to them in order to get them out of the way. Similarly wheat stacks were burned. I asked the farmers why they did not utilize the great value of this manure and they replied that the land was rich enough to raise a crop without having to go to that trouble. This land in the Red River Valley of Minnesota and the Dakotas when first cultivated would produce from 30 to 50 bu of wheat per acre. I do not know just what the average yield is now, but I believe it is between 12 and 18 bu. It just barely justifies a farmer's labor in planting and harvesting the wheat. If this same land had been cultivated in a rational way, with a rotation of crops, there is no reason why it could not have retained its original fertility. There are fields in Europe that have been cultivated from the days of Caesar and yet they are perhaps more fertile now than two thousand years ago.

Boulder Dam—The Topographic Map Played an Important Rôle in This Mammoth Project
Photo by Courtesy U. S. Bureau of Reclamation

MAPS FIT INTO THE PICTURE

But what has all this to do with mapping, some one will ask. In most cases there are no maps showing the slopes of ground and the locations of the areas where soil erosion is going on. Suppose a farmer tries to protect his land from soil erosion and the farmer higher up the valley is not conserving his soil. It is possible that there will be a flood of waters coming from the upper farm, and the efforts of the farmer lower down the valley will be nullified by the carelessness of his neighbor.

That soil erosion must be attacked in a national way as well as by individual farm owners is fully recognized by the Department of Agriculture, which has been conducting soil erosion studies on a large scale in many of the states. In making those studies the first things called for are maps, and suitable maps being notoriously lacking, they have to be made, and made in a hurry. And, of course, these maps are suited only to the problems in hand. Could the money spent in providing maps for the soil erosion studies in these states be applied to the national mapping program, great economy would result. Why not anticipate future studies by having the maps ready before the studies are undertaken?

Selection of the Most Economic Route for a Highway Requires Good Maps
View on U. S. 85, North of Newcastle, Wyo. Photo by Courtesy U. S. Bureau of Public Roads

To mention another field—there is a constant struggle to keep our forests from deterioration. Ever-present forest fires, most of them due to carelessness, destroy probably as much timber per year as would be produced as the result of replanting.

Problems of the forests, soil, rivers, and streams can be solved only by having a knowledge of the terrain, and this knowledge can be obtained only from accurate maps.

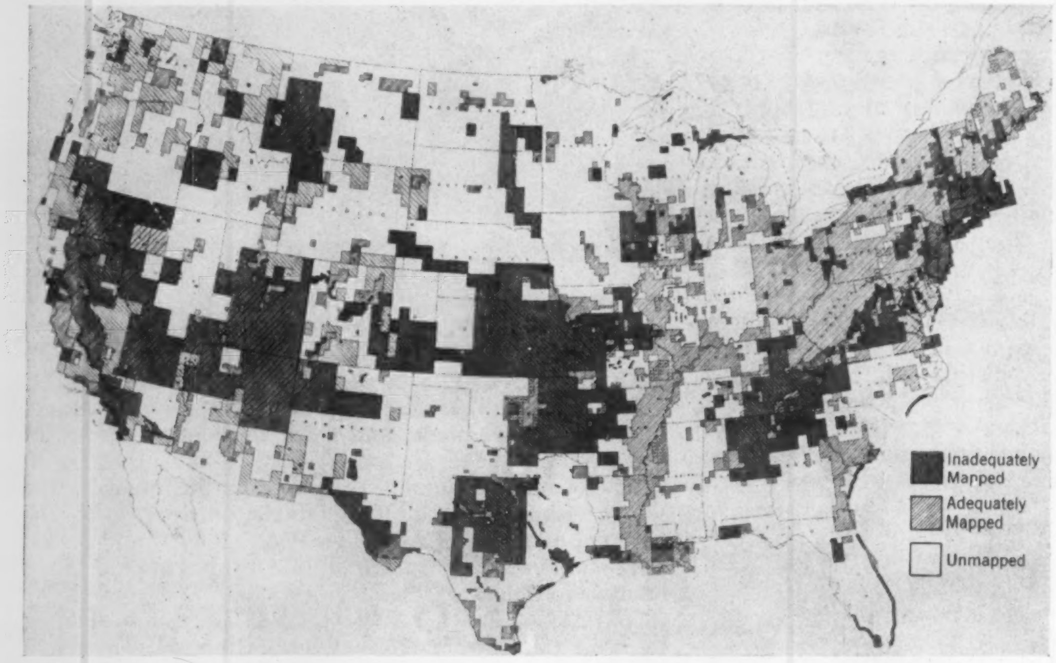
HIGHWAYS, TOO, REQUIRE MAPS

During the past few decades, we have spent untold millions on the extension of our highways, but in many cases the locating and building of the highways have been done without adequate knowledge of the areas covered; and in consequence there have resulted many poor locations and poor designs for highway structures. An engineer from the South told me recently that in his state, which has only part of its area mapped, the annual cost to the State Highway Department of replacing washed-out bridges, culverts, and sections of highways is enormous. He blames most of the destruction on the lack of knowledge of the terrain. A good map will give for every river, stream, and gulch the exact area that drains into the watercourse. Without knowing whether this area is large or small, the highway engineer is likely to make mistakes in deciding on the waterway to be allowed for bridges and the dimensions of his culverts.

This engineer expressed the opinion that a complete topographic map of his state would save almost as much money to the highway department annually as the mapping would cost. Does it not look as if we are bungling to continue to work without maps?

SORT OF A GEOGRAPHICAL CENSUS

Every ten years we take a census of our country to obtain knowledge of its population and industries and to collect other information, which is out of date by the time the reports of the census have been prepared and printed. Yet these census reports are valuable and justify their cost. They undoubtedly help our people in industry, commerce, and transportation. But would it not be well to consider also that the map gives us a census of what is on the land and that the map once made and made accurately is of permanent value?



FORTY-SEVEN PER CENT OF THE COUNTRY HAS BEEN TOPOGRAPHICALLY MAPPED (NOVEMBER 1934)
But Only One-Half of These Maps Meet Present-Day Requirements

All we need to do to keep it strictly up to date is to have an airplane fly over the mapped area once in five or ten years and take photographs of the country. From these photographs, the map-maker can see at a glance what new features have come into existence since the map was made. These can be put on the new edition of the map. Then again, the pictures will show that certain features, such as houses or forests, have been destroyed, and should be omitted.

The mere question of the use of our metals should be a matter of concern. The amount of high-grade iron ore that we have is not inexhaustible. We pride ourselves upon developing so much steel per year, and the chances are that a large part of it rusts out. Junk piles are seen almost everywhere. Why not conserve our metal? There is a sentiment now, which is rather widespread, in favor of using non-corrosive alloys. Of course one will say that it costs more to use non-corrosive alloys or scrap iron than new ore. That may be true, but some day the human race will find its supply of iron ore pretty low. Far better to put our efforts, thoughts, and energies to using our resources in a rational way rather than to exhaust them by using great quantities at less expense per unit mass of material to save a few dollars.

In the matter of fuels, it is claimed that in many cases it is cheaper to use oil, gas, and coal than water power. This may be true today. But some day we may find the quantity of fuels running low and then we will have to make full use of water power. Why not let the use of water power be coincident with the rational use of natural fuels? Then, again, let us conserve our rivers by maintaining the sources of their waters; otherwise they may deteriorate so that they cannot be used for power.

No matter what we say about our natural resources, their extent, or their uses, we are brought squarely up against the question of whether we have an adequate knowledge of our area. The answer of course must be "No." We have been mapping the country in a more or less haphazard way for many decades, but funds devoted to mapping have been scarce, and today we find that no more than 47 per cent of the United States is covered by maps that show elevations and slopes. More than half of those maps were made so many years ago, when demands were on a simpler scale, that they are of little or no value now. They must be made over. We should not blame the early map-makers. About all they were attempting to do was to show the general character of the country. They met the needs of their own times; but the needs of today are more exacting and therefore the maps must be of higher grade.

The time has come for our people to wake up and to make a complete inventory of their natural resources and then to make plans that will enable them to use these resources in a rational way. Let us stop thinking that all our energies should be employed in collecting natural resources and using them up as fast as possible. By working in that manner we are destroying the potential wealth of our country. Let us devote at least some of our energies to finding out what natural resources we have. Let us make maps so that we can discover what we have and how we can use it.

If we should consider the cost of maps in human energy rather than in dollars, we would see that we could well afford to put to work on the mapping of the country as many persons as could be employed. A plan has been made for completing the topographic mapping of the country within ten years. It was approved by the Board of Direction and printed by the Society in CIVIL ENGINEERING in February 1935. Whether this plan will be put into effect is not known. With so many engineers available for employment, now would be the ideal time for starting a great mapping program. They would be kept on professional work; their morale would be maintained; and they would be better engineers as the result of having had intensive training in what may be called higher surveying and mapping. We are working without maps in a map-minded era. It is a condition that is unfortunate and it should be remedied.

Why Skyscrapers Are Barred in London

Public Opinion in England Is Not in Favor of Tall Buildings

By Robins Fleming
American Bridge Company, New York, N.Y.

While criticism of the modern skyscraper on various grounds is by no means uncommon in this country, as pointed out by Dr. Fleming in his article, "For and Against the Skyscraper," published in "Civil Engineering" for June 1935, most of the unfavorable American comment has been directed not so much at the individual skyscraper as against the congestion of traffic and diminution of light attributed to close grouping of tall buildings. In England, however, the weight of opinion seems opposed to the concept itself. Commercial buildings in London are limited by law to a height of not more than 80 ft, except by special consent of the City Council. The difficulty of supporting the heavy loads imposed by tall buildings upon the soft, moist London subsoil has been advanced as a practical reason for avoiding them. But from Dr. Fleming's study of English comment, presented in the following article, the greatest deterrent would seem to be the strict application of the doctrine of "ancient lights."

London has no commercial buildings high enough to be classified as skyscrapers. There are many, of course, which satisfy the criterion of skeleton construction. On the other hand, New York, which rivals London in wealth and population, has 2,500 buildings ten stories or more in height. English economists, architects, engineers, and editors are united in expressing disapproval of the skyscraper. It has been declared unsafe, unhealthy, unsightly, and against public welfare. The stability of the skyscraper in earthquakes has been questioned. "The arguments that can be brought against the adoption of high buildings are many and mighty," wrote Raymond Unwin (later Sir Raymond Unwin) in a paper, "Higher Building in Relation to Town Planning," published in the *Journal of the Royal Institute of British Architects* for January 12, 1924. "The conclusive argument against high buildings," he says, "is that no real gain is secured to the community by adopting them."

Few comments are as mild as those of Gilbert K. Chesterton, who objects because they are not suited to the sky of London. In an essay "On Architecture" appearing in *Generally Speaking—A Book of Essays,* published in 1928, he writes of the skyscraper, "It is suitable to the hard light and the cloudless spaces about the towers of Manhattan; and there, like anything else that is in its place, it is a splendid thing to see. But even the invaders who have brought over American buildings have not yet imported any large fragments of American sky."

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The Mount Royal, Oxford Street, London
An Example of a Modern Soundproof Apartment Building.
Sir John Burnet, Tait, and Lorne, Architects

For forty years the London building code has contained the following provision: "A building (not being a church or chapel) shall not be erected or be subsequently increased to a greater height than eighty feet (exclusive of two stories in the roof and of ornamental towers, turrets or other architectural features as decorations) without the consent of the Council." The code of 1894, of which the foregoing is a paragraph, was adopted after considerable discussion. Its object was "to do away with the existing acts of the previous fifty years, which had become complicated, doubtful and insufficient and to replace them with a new act with clearness and simplicity of construction, wording and definition."

More than any other single deterrent to the building of skyscrapers in London is what is known as the "law of ancient lights." Webster defines ancient lights as "windows and other openings that have been employed for more than 20 years," and adds, "In England and in some states of the United States the owner acquires a prescriptive right to maintain them." Blackstone is quoted in *A New Dictionary on Historical Principles*, edited by Sir James A. H. Murray as saying: "If a house or wall is erected so near to mine that it stops my antient lights..., I may enter my neighbour's land and peaceably pull it down."

A decree of Parliament commonly known as "The Prescriptive Act, 1832," reads in part: "When the access and use of light to and for any dwelling house, workshop, or other building shall have been actually enjoyed therewith for the full period of twenty years without interruption, the right thereto shall be deemed absolute and indefeasible, any local usage or custom to the contrary notwithstanding, unless it shall appear that the same was enjoyed by some consent or agreement made or given for that purpose by deed or writing." Alfred C. Bossom, an English architect who during his residence in the United States designed several skyscrapers, calls the act "an instrument of extortion and obstruction." He writes, "No such legal barbed-wire entanglements confronted the designers of the American skyscraper."

This doctrine of prescription is discussed in a comprehensive article, "Easements, More Particularly Light and Air," by W. E. Watson, Barrister at Law, in *The Journal of the Royal Institute of British Architects*, issue of September 17, 1927. "The doctrine of prescription," the author says, "was founded on a rule that if a man or his ancestors used or enjoyed a right peaceably or continuously from time immemorial he was deemed to become the owner by prescription." He goes on to say, "The easement of light may be defined as the right to prevent the commission of a nuisance in respect of the enjoyment of a building intended for human occupation by a diminution of natural light within that building. In short, it is no more than a right to protection from a particular form of nuisance." The Act of 1832 fixed the period that establishes the right. The right can only be incident to a building or artificial section intended for a habitation; it cannot exist over land in its natural state—as, for instance, over a garden. Complex questions often arise. "The question of ancient lights is a difficult one," said Sir William Bull in a discussion, "and I can never make up my mind as to what property people can acquire in light and air."

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EXTENSION TO BUILDING OF MESSRS. COOK, SON, AND COMPANY, ST. PAUL'S CHURCHYARD, LONDON
Messrs. Searle and Searle, Architects

Although the prescriptive act defined the period required to establish the right, it did not define the nature or extent of injury which would justify an action at law. This was left to be settled by an endless procession of cases, of which the case of Home and Colonial Stores v. Colls is probably the most famous. In December 1900 an injunction was sought in the Chancery Division by the Home and Colonial Stores to restrain Mr. Colls, a builder and contractor, from erecting a building in such a way as to lessen the amount of light they then enjoyed. Mr. Colls proposed to erect a new building to a height of 42 ft, the building it replaced being but 19 ft 6 in. high. Between his building and that of the plaintiff's was a street 40 ft wide. "There is no difficulty about the facts in the case: the difficulty is in the law," said the presiding justice. The plaintiffs claimed that the new building would seriously lessen the light to their ground floor and that the basement or pavement lights would be materially darkened. For these reasons they asked for a mandatory injunction against the erection of the new building. The defendant admitted that the amount of light would be lessened but asserted that it would still be ample to enable the plaintiff to carry on his business. The justice gave judgment that the Home and Colonial Stores were not entitled to an injunction and dismissed the case with costs.

From this decision the plaintiff appealed. Meanwhile Mr. Colls went on and finished the new building. The court of appeal reversed the decision of the court below and ordered the new building to be pulled down to such a point that the ancient light enjoyed by the company would not in any degree be diminished. From this decision an appeal was taken by Mr. Colls to the House of Lords, the important question being whether a mere diminution of light gave the party affected a right to an injunction or merely a right to damages. The House of Lords reversed the decision of the court of appeal and upheld that of the court of first instance. The decision was thus a decided victory for Mr. Colls.

The arguments made and the previous decisions quoted in this "all-important" case are interesting reading. The decision of the court of appeal, said the Lord Chancellor, rested on a false analogy, "as though the access and enjoyment of light constituted a sort of proprietary right in light itself." A case of 1752 was quoted by the Lord Chancellor in which Lord Hardwicke ruled: "It is not sufficient to say it will alter the plaintiff's light, for then no piece of ground could be built on in the City." The decision in favor of Mr. Colls was welcomed because, as one writer said, of its sound common sense— "for, stripped of all verbiage, the judgment . . . lays it down that mere diminution of the light received by a window will not necessarily incur a penalty—either injunction or damages. The diminution must be such that it amounts to a nuisance. It must be substantial, and so as to render occupation of the part affected uncomfortable according to the ordinary notions of mankind, or, if used for business, so as to be an interference with its beneficial use and occupation."

This type of case is still numerous. Only this year, *The Builder* reports a case somewhat similar to Colls's, that of Fishenden v. Higgs and Hill, Ltd. The justice before whom the case was first heard saw no alternative to granting the injunction asked for, and ordered the defendant to pay the costs of the action. Thereupon an appeal was taken. The court of appeal inclined toward damages rather than an injunction and remitted the case back to the Chancery Division for the purpose of ascertaining and assessing damages. Leave to appeal to the House of Lords was denied.

In less serious cases where a mandatory injunction is not called for, buildings are often erected before suit is brought by the owner of adjacent property for damages. As is to be expected in suits at law, the estimate of damages made by the plaintiff differs widely—at times very widely—from the estimate of the defendant. On this subject Percy J. Waldram, whose name often occurs in testimony as to the amount of damages, says, "The large differences as to appropriate damages in ancient light cases are not necessarily due to the incompetence of valuers. Often they result from the practice of computing damage, on the one hand by calculating the real damage caused, and on the other hand by estimating what it would be worth to the building owner to buy off the real or imaginary right of some neighbor." A parallel case occurs in the United States when the value of a property is based on the anticipation that at some time a skyscraper will be erected upon it.

It may be of interest to mention a letter of Mr. Waldram to *The Times* (London) printed under the heading, "Higher Buildings. Changing Opinions in America," in the issue of January 29, 1929. In it the writer quotes from the report of what is known in New York City as the "Mayor's Committee on Plan and Survey." In June 1926, the Mayor had appointed a committee of some 500 prominent citizens to make a survey of the city and plan for its future development. The committee made its report in January 1928. The Subcommittee on Housing, Zoning, and Distribution of Population entitled one of its sections "The Evil of High Buildings Should Be Effectively Grappled With," and in this section was a heading, "We May Come to a Law of Ancient Lights." Mr. Waldram in his letter quotes from the report: "Buildings are much too high.... The tendency is to build higher and higher.... Existing public open spaces have become inadequate, hemmed in as they are by canyon walls.... Failing to adopt this practical remedy of limiting the height of future buildings ... we shall undoubtedly be forced to come to the remedy which prevails in England—known as the law of ancient lights. The skyscraper is unknown in England. And yet the great world city of London, larger even than New York in population, manages to prosper without it, as do all the cities of Europe." This part of the report must have given a peculiar satisfaction to our British friends, for Mr. Waldram's letter was reprinted in at least two technical periodicals.

At different times vigorous efforts have been made to lift the restrictions on higher buildings in London, although the writers advocating them are almost unanimous in disclaiming any liking for the American skyscraper. *The Times* of January 1, 1920, says editorially, "The provisions of the London Building Act impose strong and, perhaps, desirable limitations as regards the height of buildings, but if accommodations must be found and lateral extension is impossible the alternative of going higher may have to be faced." "I am not suggesting that we should adopt the policy of the skyscraper," writes Delissa Joseph in a letter to *The Times* a few days later, "I am only advocating that the restrictions on the height of buildings should be so modified as to allow buildings of, say, 150 to 200 ft in height to be erected in suitable open situations." Sir Sydney Skinner said before the Royal Institute of British Architects on May 28, 1923, "I am not at all concerned with 'skyscrapers' and I do not know that I want to see skyscrapers in London; but I can conceive of no difficulty in having buildings of a reasonable height, say 125 ft, on wide thoroughfares."

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Burnham Court, N.W., London
Another Type of Apartment Building Recently Erected. Tatchell and Wilson, Architects

The Council of the Royal Institute of British Architects in 1921 "after careful consideration" came to the conclusion that "any general increase in the height of buildings would be detrimental to the amenities of London," and that "the principle of increasing housing accommodation by means of high buildings is a revolutionary one, and undesirable from the point of view of family life."

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Crompton Court, South Kensington, London
Part of a Large Block of Residential Flats. Stanley Peach and Partners, Architects

In response to an invitation extended by the American Society of Civil Engineers in recognition of the kindness which had been shown them on their visit to England four years earlier, a representative body came from England to New York in September 1904. Sir William Henry White, in describing the visit after his return, said (*Proceedings, Institution of Civil Engineers,* Vol. 160, pp. 64–99): "It is a novel experience for an Englishman to be asked to lunch on the twentieth story, and to find at that great height the conveniences of a club combined with a magnificent view over the harbor of New York. The population of one of these great buildings during working hours is enormous. In one case it was stated that nine or ten thousand people were accommodated.... We cannot, however, under our law of 'ancient lights,' reach the state of congestion in traffic which results in New York and elsewhere from the multiplication of buildings 250 to 300 ft high, such as surround and dwarf Trinity Church and its tower. The spectacle presented by these buildings from the harbor of New York is remarkable and interesting; but, personally, I am not desirous of seeing a similar group of buildings in any city of Great Britain."

Twenty-seven years later the party could have dined on the eighty-sixth floor of the Empire State Building, 1,050 ft above the sidewalk level, or gazed from the tower of that building, 200 ft higher still.

Civil Engineering is indebted to *The Builder,* published at 4 Catherine Street, Aldwych, London, for its services in making available the photographs of the buildings reproduced in this article.

Studies of Cold-Laid Bituminous Concrete

Apparatus for Testing Bituminous Pavements Reproduces Effects of Motor Truck Traffic

By A. T. GOLDBECK

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

DIRECTOR, BUREAU OF ENGINEERING, NATIONAL CRUSHED STONE ASSOCIATION, WASHINGTON, D.C.

ONE of the widely used bituminous concrete pavements is the cold-laid liquefier type. But, as evidenced by wide variation in state specifications, highway engineers do not agree on the sizes of aggregate or on the amounts of asphaltic cement, liquefier, and hydrated lime best calculated to combine stability and durability of the finished pavement with facility in placing. In seeking facts which might point the way toward a more uniform specification for the cold-laid liquefier type of mixture, the National Crushed Stone Association's laboratory, directed by Mr. Goldbeck, developed an apparatus which closely simulates the effects produced by heavy traffic on a bituminous pavement. The accompanying article is abstracted from the paper delivered by Mr. Goldbeck on May 2, 1935, before a meeting of the Providence Engineering Society.

A COMPARISON of the various state specifications covering the mixing and placing of the cold-laid liquefier type of bituminous concrete pavement reveals no unanimity of opinion regarding the proper gradation of aggregate or the proper percentage of asphaltic cement, liquefier, and hydrated lime to be used. One needs little imagination to realize the difficulties producers have who manufacture this type of pavement complying with widely different specifications. These difficulties were brought to our attention in the National Crushed Stone Association, and we decided that there must be specifications that would be equally suitable within a rather wide territory, irrespective of state boundaries. We accordingly decided to determine, if possible, the most desirable specification limits. Late in 1933 the highway department specifications for four Eastern states were analyzed. For the purposes of this paper they will be designated as States A, B, C, and D.

To compare these specifications adequately it was necessary to express in the same terms the gradation requirements of each state. In Fig. 1 will be found the limits of gradation for the base or binder courses, and in Fig. 2 the gradations for the top courses, both representing mechanical analyses which include the so-called mineral filler.

Referring first to the base course gradations, shown in Fig. 1, it will be noted that the top size in State A is through a sieve with 1-in. square openings, whereas the top size in the other three states is through a screen with 2-in. round openings. On the other hand, the specifications for the other states call for a very much higher percentage of the small-sized material. But as regards the gradation requirements for the top course (Fig. 2), it is to be noted that State A has the largest size in the top course. Also, note the wide range in percentage of small sizes among the various states.

Obviously, so wide a range in size requirements leads to a wide difference in the characteristics of the final mixes. Those mixes having a small percentage of fines are characterized by openness of texture, while those containing a high percentage of fines approach more nearly the appearance of modified Topeka pavements. Such mixes are tough and difficult to work, but at the same time they are more dense and waterproof in their early life than the mixes lacking in fines.

In Table I are shown the extreme requirements and also the mean requirements for the four states, and here again wide variations in the percentages of the several ingredients will be noted. Observe that in the base course, the percentage of asphaltic cement varies from $2^1/_2$ to 6. Note the high lime percentage specified by State D in contrast with the other states. Referring to the top course, there seem to be inconsistencies in the percentages of the respective ingredients. State A, with a gradation requiring a minimum of fines, nevertheless requires the highest maximum percentage of asphalt of all four states.

There is also some variation in opinion as to the characteristics of the asphaltic cement to be specified. States C and D permit a very much harder material than States A and B, but State D insists on a very much higher ductility than either State A or State B. However, asphalts with a penetration of 85 to 100 are permissible in all four states. And finally, there is some difference in the volatility of the liquefiers specified, although the same liquefier could be used in all four states.

DESIRABLE LIMITATIONS FOR SPECIFICATIONS

The ideal cold-laid bituminous concrete pavement should have the following characteristics:

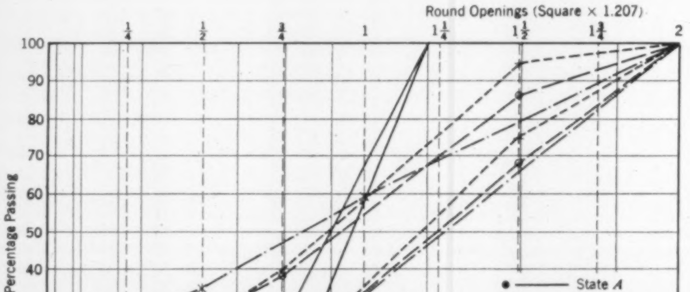

FIG. 1. GRADATION OF BASE COURSE AGGREGATES, FOUR STATES

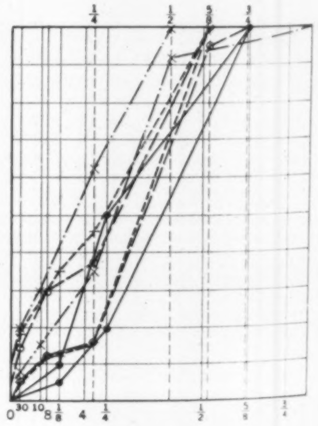

FIG. 2. GRADATION OF TOP COURSE AGGREGATES, FOUR STATES

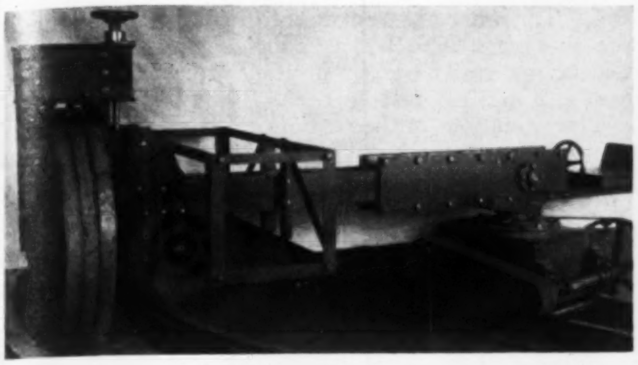

Fig. 3. Circular-Track Testing Apparatus Equipped with Roller Assembly

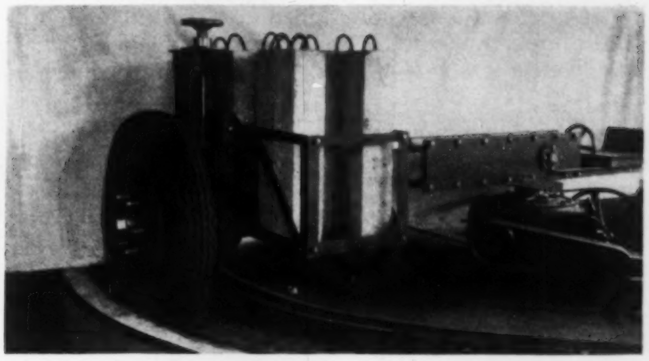

Fig. 4. Circular-Track Testing Apparatus Equipped with Rubber-Tired Wheel

1. It should be stable, that is, resistant to shoving and displacement under the action of traffic.
2. It should be durable or capable of high resistance to ordinary highway traffic, extraordinary traffic conditions such as are produced by vehicles equipped with tire chains running in restricted lanes, and water action over long periods.
3. It should be capable of being shipped and rehandled from the truck or car without excessive difficulty.
4. It should be capable of being spread into place either by hand or by mechanical means.
5. It should be so graded that uniformity will be possible; that is, segregation must be minimized so that fines will not be prevalent in some spots and coarse fragments in others.
6. Excessive "fatness" must be avoided, for this leads to bleeding, possible instability, and slipperiness.
7. It must be essentially an open type of surface initially, for the liquefier must be permitted to volatilize and thus allow the asphalt to harden to the proper consistency.
8. It should have a non-skid surface.

With these facts in mind, our investigations were started to determine the desirable limitations of the cold-laid liquefier type of mix, making use of what seems to be a very practical laboratory service method.

In order to simulate service conditions as nearly as is possible in the laboratory, we decided on the use of a circular track upon which rolling wheel loads might be operated. The track is 14 ft in mean diameter and is built in a trough-shaped cross section having a width of 18 in. and a depth of 6 in. The test mixes are laid in sections in this trough, where they are subjected to the rolling action of traffic. Means are provided to control the temperature of the track.

A radial arm to the outer end of which is attached either a roller (Fig. 3) or a rubber-tired wheel (Fig. 4), as the case requires, is mounted at its inner end on a vertical speed reducer, driven by a 3-hp reversible, variable-speed motor, using a V-belt drive for that purpose.

The roller used in rolling the specimens is 3 ft in diameter and weighs 200 lb per in. of width. This weight can be increased to 400 lb per in. of width if desired. The rubber-tired wheel employed for test purposes is one such as would be mounted on a 2-ton truck. It is fitted with a 7 by 20 in. pneumatic tire, inflated to a pressure of 50 to 55 lb per sq in. When loaded to capacity, the total load on the tire is 1,900 lb. Under test this wheel is driven by means of the radial arm at a speed of approximately 4 miles per hr. For the purpose of determining the effect of the roller or the wheel on the road surfaces, vertical measurements are taken at numerous points by the use of a depth gage mounted on a sliding bridge that spans the test sections in any desired position.

PRELIMINARY TESTS USING EXTREMES AND AVERAGES OF STATE MIXES

In view of the range of gradation and mix requirements permitted in each of the states, it was decided to make up 3 mixes for each state specification, one conforming to the average requirements and the other two to the extreme limits of the specifications. Thus 12 mixes in all were made up and laid in the track. The aggregate gradations were based on the analyses shown in Figs. 1 and 2, and the proportions given in Table I. Of course, the mix having the highest percentage of asphalt was used with the gradation having the greatest amount of fines, and the coarsest gradation was used with the lowest percentage of asphalt.

Limestone used in these tests had a specific gravity of 2.76, a percentage of wear of 3.3, an average toughness of 6, and an absorption of 0.3 per cent. The liquefier adopted had an over-point not greater than 275 F, and a dry point not greater than 425 F by the American Society for Testing Materials distillation method. The asphaltic cement used, at 77 F, under a load of 100 g showed a penetration in 5 sec of 90.

The mixtures were rolled into place with the laboratory roller (200 lb per in. of width), and the volumes of the

Table I. Percentages of Materials Under 1933 Specifications of Four States, as Indicated by Requirements of Each Fine, Medium, and Coarse Gradations

	State A Mixes			State B Mixes			State C Mixes			State D Mixes		
Materials	1	2	3	4	5	6	7	8	9	10	11	12
BASE COURSE												
Aggregate	92.0	93.55	95.1	92.2	93.75	95.35	93.5	95.0	96.6	91.2	92.9	94.6
Liquefier	1.0	0.7	0.4	1.0	0.7	0.35	1.5	0.95	0.4	*1.3	*1.1	*0.9
Lime	1.0	0.75	0.5	1.0	0.75	0.5	1.0	0.75	0.5	2.5	2.0	1.5
Asphaltic cement	6.0	5.0	4.0	5.8	4.8	3.8	4.0	3.3	2.5	5.0	4.0	3.0
TOP COURSE												
Aggregate	90.0	92.5	94.1	91.0	92.57	94.15	91.5	93.3	95.1	89.2	90.5	92.1
Liquefier	1.0	0.7	0.4	1.0	0.68	0.35	1.5	0.95	0.4	1.3	1.1	0.9
Lime	1.0	0.75	0.5	1.0	0.75	0.5	1.0	0.75	0.5	2.5	2.0	1.5
Asphaltic cement	8.0	6.5	5.0	7.0	6.0	5.0	6.0	5.0	4.0	7.0	6.25	5.5

* Quantities determined on the basis of judgment, as no percentage was given in the state specifications.

rolled sections were determined by vertical and horizontal measurements. The compacted thickness of the base course was 1¹/₂ in., and that of the top course, ¹/₂ in.

After rolling, the sections were cured by applying a gentle current of air overnight at room temperature and were then subjected to 5,000 passes of the pneumatic-tired wheel carrying a load of 1,900 lb. The results of this part of the test are shown in Fig. 5 (*a*). Perhaps the outstanding feature of this test is the instability of the extremely fine graded section of the State D mixes, as shown by the deep rutting which occurred under traffic. It will also be noted that there is a slight tendency for the coarse sections to show less rutting than the fine-graded sections, except for State A mixes, which were low in fines and tended to tear out on the surface.

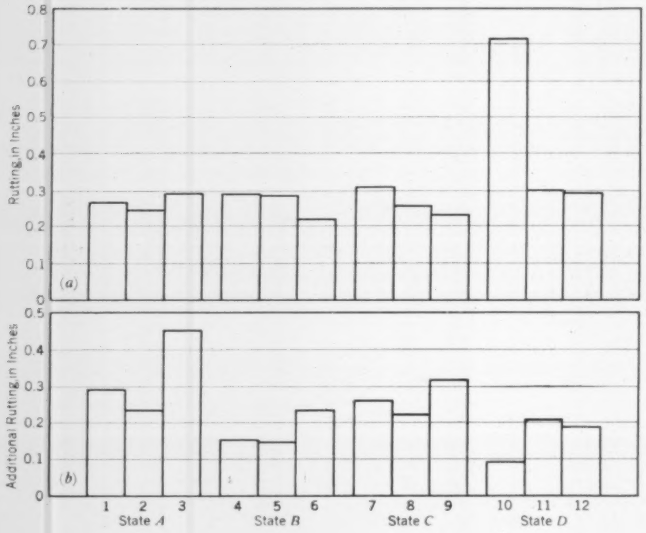

FIG. 5. RESULTS OF TESTS ON MIXES BASED ON SPECIFICATIONS OF FOUR STATES

(*a*) Stability as Shown by Dry Rutting Under 5,000 Passes of Tire
(*b*) Durability as Shown by Wet Rutting Under 10,500 Additional Passes of Tire with Chains

After 5,000 passes of the wheel over the dry surfaces, sufficient water was turned onto them to cover and impregnate them, and to keep them wet. Then 10,500 additional passes of the rubber-tired wheel were made. Depth measurements for rutting were again taken, with the results shown in Fig. 5 (*b*). Measurements as shown on this graph were taken at the outside of the rut, where the raveling was most pronounced. This is an interesting chart when compared with Fig. 5 (*a*). While the tests shown in the two charts are regarded as preliminary in nature, they point to some trends, as follows:

1. A dense, fine gradation (No. 10) may lead to instability under traffic, but is highly resistant to the action of water and traffic.

2. There seems to be a limit in fineness of gradation beyond which fineness may lead to lesser durability and lesser stability (2, 5, and 8 as compared with 1, 4, and 7).

3. Surface mixes that are rather open and porous are not as durable as somewhat denser surface mixes. (1, 2, and 3 are not as durable as 4, 5, 8, 10, 11, and 12.)

4. The order of excellence of the various mixes under the shoving due to traffic, and combined shoving and tearing under wet-track conditions are as follows: Nos. 5, 4, 6, 2, and 12, 8, 11, 9, 1, 7, 3, 10.

The gradations of the best of these surface mixes when compared with the best of the mixes used in other tests served as a basis for the gradation suggested at the end of this article.

INVESTIGATION OF BASE COURSES

The preceding tests, which were regarded as preliminary, involved the entire pavement, including the base and top courses. It was thus uncertain how much the movement of the base course contributed to the rutting. Another test run was accordingly made on the base course alone, in order to determine its stability.

As the gradation of the aggregate is one of the important variables, 12 different gradations were used, as shown in Fig. 6. Note the wide range in these gradations. For illustration, mixes 3, 6, and 9 contained a lot of fine material and produced a dense mix, whereas mixes 1, 4, and 7 contained very little fines and resulted in an open mix. Naturally, because of these variations in gradation, the proportions of the mixes had to be different. Open mixes, having a comparatively small surface area to cover, required a low percentage of asphaltic cement, whereas the dense mixes required a higher percentage. The proportions of these different mixes are shown in Table II.

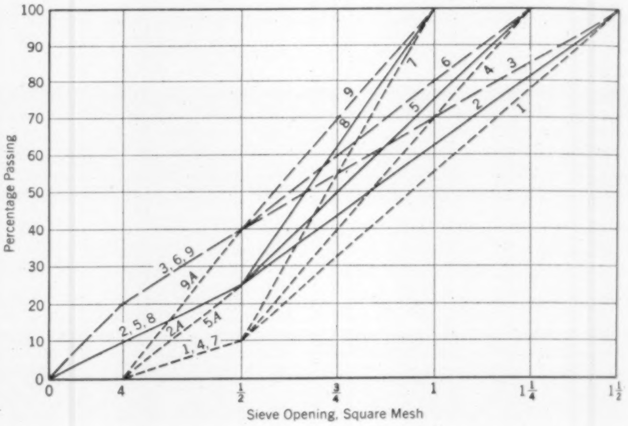

FIG. 6. GRADATION OF AGGREGATES FOR INVESTIGATION OF BASE COURSES

The asphalt had a penetration of 90 and a liquefier had an initial boiling point of 217 F and a final boiling point of 428 F. These base courses were rolled into place and were then given a skin treatment of topping mix, just enough to fill the voids and no more. After rolling with the roller attachment, weighing 200 lb per in. of width, the base was cured for 4 days, during which time it was thoroughly rolled. The loaded tire was then weaved over the surface for a total of 700 circuits of the track to further compact it. The total thickness of the base courses was approximately 2 in. in all cases.

The stability test was made with the pavement at a

TABLE II. PERCENTAGES OF MATERIALS USED IN TESTS OF BASE COURSES

	MIX NUMBER											
MATERIALS	1	2	3	4	5	6	7	8	9	2A	5A	9A
Aggregate	95.6	94.9	93.7	95.5	94.8	93.5	95.25	94.2	93.1	95.3	95.2	93.8
Liquefier	0.5	0.75	1.0	0.5	0.75	1.0	0.5	0.75	1.0	0.75	0.75	0.75
Lime	0.5	0.75	1.0	0.5	0.75	1.0	0.5	0.75	1.0	0.75	0.75	0.75
Asphaltic cement .	3.4	3.6	4.3	3.5	3.7	4.5	3.75	4.3	4.9	3.2	3.3	4.7

temperature of 94 F. The test consisted of running the loaded tire in a single path in the center of the track for 6,000 circuits, taking measurements for change in level at the end of every 1,000 circuits by the use of a depth gage mounted on a sliding bridge. At the end of 6,000 passes, it appeared that the worst mixes were Nos. 3, 7, and 9A, and the best, Nos. 4, 5, 6, 8, and 5A. Of the open mixes—1, 4, and 7—Nos. 1 and 4 were both good, but No. 7, having a small maximum size, was not so good. Of the dense mixtures—3, 6, and 9—No. 6 was among the best, No. 9 intermediate, and No. 3 was one of the poor sections. Nos. 2, 5, and 8 are the intermediate gradations and were uniformly good. It would seem, therefore, that a large amount of fines might lead to instability, whereas an intermediate amount and a small amount result in a more or less open texture for the base course and are indicated as having the best characteristics.

Certainly these tests point to the possibility of obtaining high stability with an open-textured base course, and since an open texture seems desirable from the standpoint of manipulation in laying the cold type of mix, the indications are that the gradation should be such that a comparatively small amount of fines is included.

The question of maximum size should be governed by the question of the thickness of the base course. Obviously, a thin base course demands a smaller maximum size than a thick base course. It is economical to use a comparatively large maximum size, and it seems undersirable to have too wide a range in gradation because of the danger of segregation, which might result in the accumulation of fines in some places and of coarse fragments in others. The maximum size must not be so great that the roller will be supported in certain spots, with a resulting lack of compression in adjacent spots.

INVESTIGATIONS OF TOP COURSES

Still another project had to do with an investigation of the durability of the top course. Various gradations, as shown in Fig. 7, were made up in the various proportions given in Table III and laid on cold-laid liquefier type bases.

These text mixes were artificially cured in place by the use of a warm current of air and were then subjected to 3,046 passes of the tire without chains and 1,628 passes of the tire equipped with chains when the surface was wet. The results of this test are shown in Fig. 8. It is quite evident that there is a difference in the resistance of these various mixes. The best mixes were 2, 5, and 8, and the worst were 9, 10, 3, 4, and 7. From the gradation curve, it will be noted that 2, 5, and 8 are mixes having intermediate gradation. Section 10 was a mix having the most open gradation, and mixes 3, 6, and 9, having large amounts of fines, did not show up well, probably because they were not very stable.

These tests are not entirely conclusive because of the possible effect of the base course on the stability of the entire section and also because it was impossible for us to run the tests at as low a temperature as would be desirable. However, indications are fairly strong that intermediate gradations—mixes 2, 5, and 8—give highly durable mixes, and furthermore that the extremely open mixes, such as 1, 4, 7, and 10, are not as durable as those containing a somewhat larger amount of fines. From the standpoint of durability, therefore, it seems desirable that a certain amount of fines be included in the topping course. Apparently something under 25 per cent passing the No. 4 sieve will give best results. The best gradation of this fine material has not been determined. Mixes 2 and 10 are the best and worst, respectively, from the standpoint of durability.

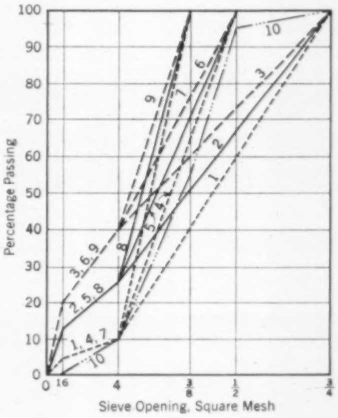

Fig. 7. Gradation of Aggregates for Investigation of Top Courses

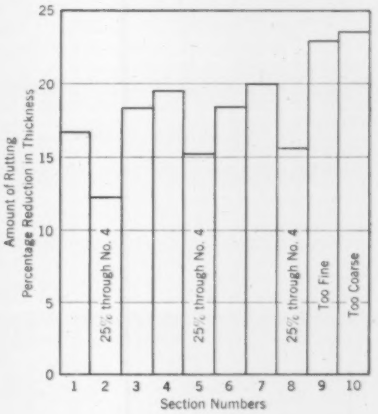

Fig. 8. Results of Tests on Top Courses

Durability as Shown by Rutting

STUDY OF MIXES OF VARYING PROPORTIONS

A fourth series of tests was made to study the effect of varying proportions of the different ingredients of cold-laid liquefier type mixes. The same gradation of material was used throughout, as follows:

Size of Screen	Per Cent Passing	Size of Screen	Per Cent Passing
1/2 in. round	97	No. 8	14
3/8 in. round	60	No. 16	7
1/4 in. round	25	No. 50	2
		No. 100	0

The liquefier had an initial boiling point of 217 F and a final boiling point of 428 F. The essential characteristics of the 12 mixes were as given in Table IV. The results of these tests are best shown in Figs. 9 and 10, which indicate that the stability of the cold-laid pavement increases with (1) decrease in liquefier, (2) increase in hydrated lime, (3) decrease in asphalt content, and (4) lowering of penetration of asphalt.

Note that it may be dangerous to use a percentage of liquefier as high as 1.50. This leads to high instability and low durability. Apparently, as far as lime is concerned, there is some toughening action, so that greater durability and greater stability result. However, there is very little difference in effect of 0.75 and 1.50 per cent lime. Note also that hydrated lime gave somewhat better results than the same percentage of limestone dust, probably because of fineness. It is indicated that the percentage of asphalt greatly affects the durability and also

Table III. Percentages of Materials Used in Tests of Top Courses

	Mix Number									
Materials	1	2	3	4	5	6	7	8	9	10
Aggregate	94.35	93.25	92.0	93.68	92.14	90.81	93.50	91.46	89.78	94.64
Liquefier	0.50	0.75	1.0	0.50	0.80	1.10	0.50	0.90	1.30	0.36
Lime	0.50	0.75	1.0	0.50	0.75	1.00	0.50	0.75	1.00	0.50
Asphaltic cement* .	4.65	5.25	6.0	5.32	6.31	7.09	5.50	6.89	7.92	4.50

* Asphalt had a penetration of 90.

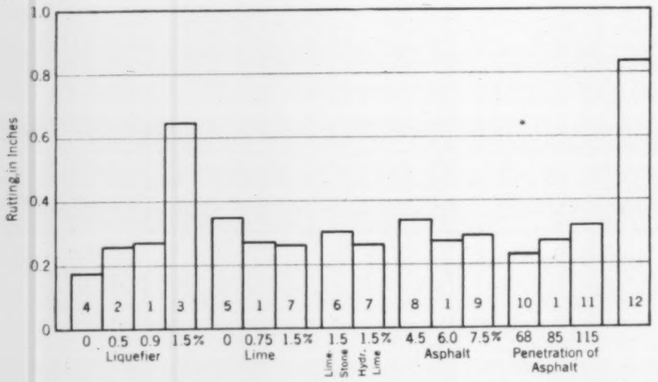

FIG. 9. COMPRESSION AND DURABILITY OF MIXES OF VARYING PROPORTIONS AS SHOWN BY DEPTH OF RUT AFTER 1,000 PASSES OF TIRE WITH CHAINS OVER WET SURFACE

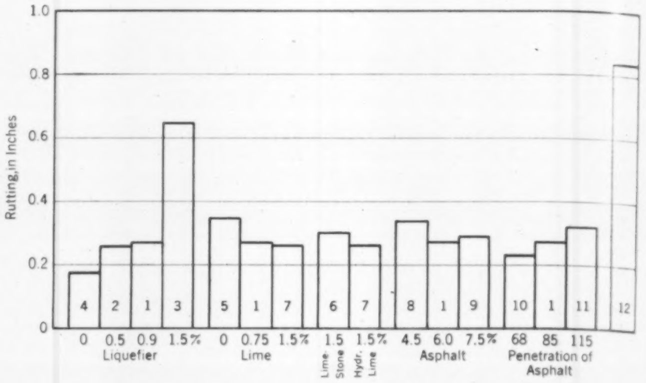

FIG. 10. STABILITY OF MIXES OF VARYING PROPORTIONS AS SHOWN BY HEIGHT OF RIDGE AFTER 1,000 PASSES OF TIRE WITH CHAINS OVER WET SURFACE

the stability. It seems that 4.5 per cent in the particular gradation of mix used is too little, for the amount of rutting produced is excessive, although the stability is high; 7.5 per cent of asphalt, on the other hand, leads to higher instability, although it does not seem to increase the durability greatly. It would seem that 6 per cent is somewhere near the correct amount for this mix.

TABLE IV. PERCENTAGES OF MATERIALS USED IN TESTS WITH VARYING PROPORTIONS

MIX NO.	LIQUEFIER	HYDRATED LIME	ASPHALT	AGGREGATE	PENETRATION OF ASPHALT
1	0.90	0.75	6.0	92.35	85
2	0.50	0.75	6.0	92.75	85
3	1.50	0.75	6.0	91.75	85
4	0	0.75	6.0	93.25	85
5	0.90	0	6.0	93.10	85
6	0.90	*	6.0	91.60	85
7	0.90	1.50	6.0	91.60	85
8	0.90	0.75	4.5	93.85	85
9	0.90	0.75	7.5	90.85	85
10	0.90	0.75	6.0	92.35	68
11	0.90	0.75	6.0	92.35	115
12	0	0	3.1	96.9	50

* In mix No. 6, 1.50 per cent limestone dust was used.

The penetration of the asphalt affects particularly the stability of the mix. A soft asphalt, as indicated by a penetration of 115, gives less stability than a hard asphalt. On the other hand, it is undesirable to use a hard asphalt in mixes of this type because a certain amount of malleability is desired on account of the openness of the mix. A hard asphalt will lead to brittleness in a short time and to lack of durability. It is believed that asphalt having a penetration of 80 to 100 is most suitable.

SUGGESTED SPECIFICATION LIMITS

As a result of these tests an attempt was made to select the mix which, with the gradation and aggregate used, would give the most satisfactory results, considering mixing, handling, laying, and service value.

TABLE V. PERCENTAGES OF MATERIALS USED IN MIX NO. 1 COMPARED WITH THE AVERAGE OF STATE HIGHWAY SPECIFICATIONS

MATERIAL	MIX NO. 1	AVERAGE OF HIGHWAY DEPTS.
Aggregate	92.35	92.3
Asphalt	6.0	5.8
Hydrated Lime	0.75	1.0
Liquefier	0.90	0.9

Mix No. 4 cannot be included for consideration, since it was a hot mix. Mix No. 2, with only 0.5 per cent liquefier, was too dry and insufficiently fluxed with liquefier to handle properly. Mix No. 1 seems to have the most desirable qualities taking the essential factors into consideration. This mix may be compared with the average proportions used by the highway departments of States A, B, C, and D, and of the District of Columbia, as shown in Table V.

The tests indicate that the average of the mixes specified by the highway departments mentioned is about correct. However, the permissible range would seem to be unnecessarily high, and the use of the extreme values permitted may not lead to entirely satisfactory results.

The specification limits for gradation of aggregates, including mineral filler but excluding lime, which were indicated as best by our tests, appear in Fig. 11. As regards aggregate sizes for top dressing, 95 to 100 per cent passing a No. 4 screen, or a $^1/_4$-in. square opening, and up to 40 per cent passing a No. 50 screen, is suggested.

The proportions of mixes that were indicated as best by our tests are given in Table VI.

TABLE VI. SUGGESTED LIMITING PERCENTAGES OF MATERIALS

MATERIAL	BASE COURSE	TOP COURSE	TOP DRESSING
Total aggregate	96.2–93.5	94.0–90.75	98.7–93.5
Liquefier	0.3–1.0	0.5–1.25	0.2–2.0
Lime	0.5–1.0	0.5–1.0	0.1–0.5
Bitumen	3.0–4.5	5.0–7.0	1.0–4.0

In conclusion, if the various state highway departments study the specification limits set forth in Table VI and determine the feasibility of incorporating them into their state standards, it is believed that stable and durable pavements would be produced and that much confusion in production would be eliminated.

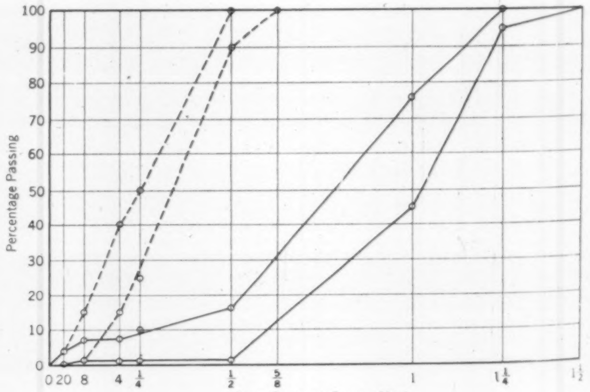

FIG. 11. SUGGESTED LIMITING GRADATIONS FOR AGGREGATES Aggregate Recommended for Top Courses Shown at Left, That for Base Courses at Right

An Invar-Tape Extensometer

Ingenious Device Gives Precise Results in Measurements on Colorado River Aqueduct

By Carl H. Heilbron, Jr., Assoc. M. Am. Soc. C.E., *and* William H. Saylor, Jun. Am. Soc. C.E.

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Before starting actual construction of the horseshoe-shaped cut-and-cover conduit being used for approximately 54 miles of the 242-mile Colorado River Aqueduct, the Metropolitan Water District authorized a series of strain, temperature, and earth-pressure tests on some full-sized experimental sections. Similar studies were made on a number of double-barreled siphons. The tests involved the determination, for 51 interior chords comprising three triangulation systems, of the exact changes in lengths due to varying load and temperature conditions. Previous methods, using fixed reference bars, were too cumbersome for practical use. To meet the situation, the District developed an invar-tape extensometer combining the flexibility of the tape with the precision of the strain gage. The new instrument, giving an accuracy of one in 100,000, made possible the early and successful completion of the tests, which were performed under the direction of Mr. Heilbron with Mr. Saylor's assistance.

In developing the final designs for the 54 miles of cut-and-cover conduit and the 52 double-barreled siphons now being constructed on the Colorado River Aqueduct, the Metropolitan Water District of Southern California built full-sized experimental sections of these parts. To determine the structural adequacy of the sections under temperature variation, shrinkage of concrete, and both normal and extraordinary backfill loads, an extensive series of strain, temperature, and earth-pressure tests were carried on. Particular attention was given to the cut-and-cover conduit, a concrete arch section 16 ft high, without reinforcing. In making these tests several new instruments were developed on the job, the most interesting being an invar-tape extensometer.

To determine the deformations under stress in any large structure of tubular section, the change in length of chords inside the section must be measured. Such measurements have been made previously with fixed invar reference bars and dial gages. This method, however, practically precludes the possibility of measuring enough chords to completely determine the deflections, for such a determination can only be made by the establishment of a relatively complex triangulation system which ties together eight or more points around the circumference of the section. It was for this reason that an attempt was made to design an instrument flexible enough for use in measuring the change in length of any chord from 2 to 20 ft long, and precise enough to give close determinations of such strains as are commonly found in engineering structures. That the resulting invar-tape extensometer is eminently successful is proved by the valuable work done with it during the past two years.

In making tests, the triangulation system shown in Fig. 1 was used. By measuring the changes in chord lengths with the invar-tape extensometer, the deformations of the structure were accurately determined; and by using these measurements in conjunction with readings of thermocouples, surface strain gages, elastic-wire strain meters, and soil pressure instruments, stress and temperature conditions were analyzed.

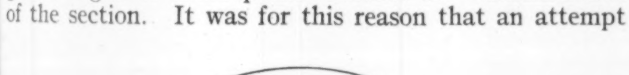


Fig. 1. Triangulation System to Determine Deformations Under Stress

Showing Chords Measured by Invar-Tape Extensometer in 16-Ft Cut-and-Cover Conduit

DESCRIPTION OF INSTRUMENT

As shown in Fig. 2, the instrument consists essentially of an invar tape, an attached dial gage, and a spring balance. Since the length of the tape may be considered constant, any change in the length of a measured chord is indicated by the dial gage. Small hardened steel balls, one at one end of the tape and the other on the end of the gage spindle, act as contact points for the instrument. The spring balance, used to control the tension in the tape, is incorporated in a sliding handle at the gage end of the instrument in such a manner that any tension put on the tape through the handle is recorded on the scale.

As the extensometer is used for the measurement of chords of many different lengths, a clamp of the screw-friction type is provided between the dial gage and the tape, by which the effective length of the tape can be changed. The exact tape setting necessary for consistent readings is obtained by fitting a small pin on the stationary face-plate of the clamp into one of a series of holes in the tape. As the dial gage has a 1-in. range, the holes in the tape are spaced $^7/_8$ in. apart, permitting a reading to be made on a chord of any length with at least one of the holes. The part of the tape not in use is wound on a reel attached to the frame.

A frame 12 in. long is required to hold the dial gage, scale, and tape clamp. Since the axis of this frame must be in close alignment with the tape to obtain a true reading, the frame extends along the tape for 6 in. and terminates in a hole through which the tape passes. By holding the instrument so that the tape is centered in this hole, perfect alignment is assured. At the other end, the tape passes through a tubular handle, attached

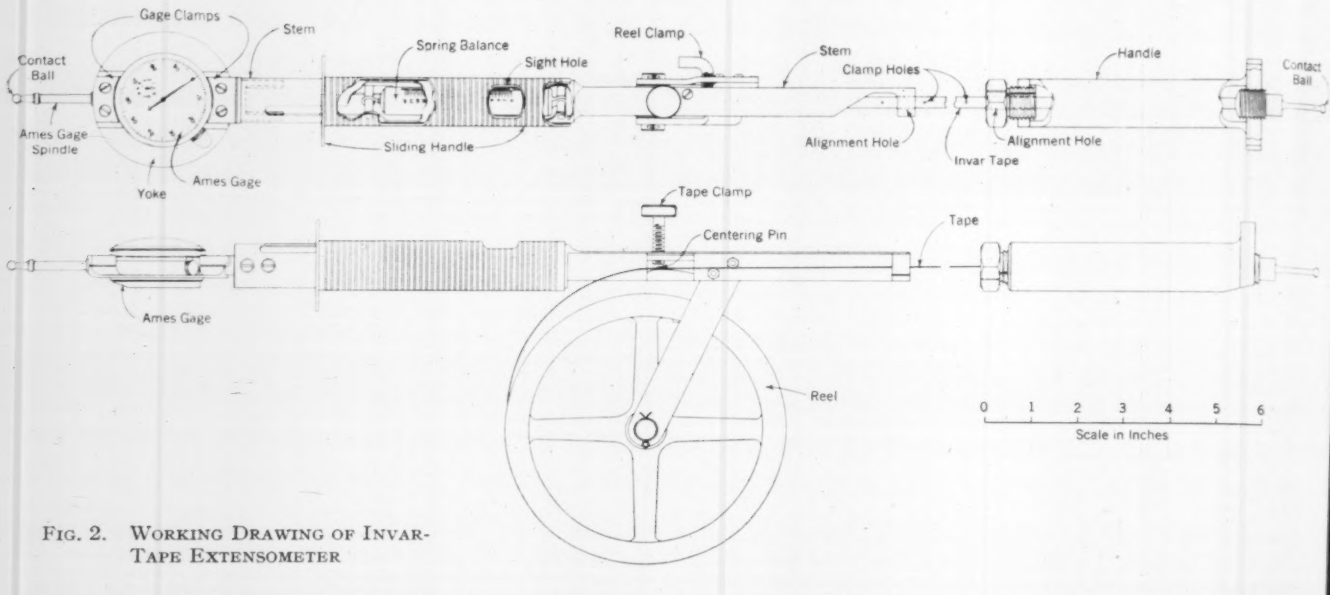

Gage Clamps
Stem
Contact Ball
Ames Gage Spindle
Yoke
Ames Gage
Spring Balance
Sight Hole
Sliding Handle
Reel Clamp
Stem
Clamp Holes
Alignment Hole
Invar Tape
Alignment Hole
Handle
Contact Ball
Tape Clamp
Centering Pin
Tape
Ames Gage
Reel
0 1 2 3 4 5 6
Scale in Inches

FIG. 2. WORKING DRAWING OF INVAR-TAPE EXTENSOMETER

to which is a short stem terminating in the hardened steel contact ball. This stem is aligned with the instrument by centering the tape in a hole at the end of the handle.

The instrument is so constructed that it can be taken apart for cleaning or repairs. Special efforts were also made to secure lightness, as this was found to contribute to ease of use.

Brass jackets, into which are screwed hardened steel inserts, are embedded in the concrete as reference points for measurements. Round holes are provided in these inserts, and in taking readings the balls at the ends of the extensometer rest upon the shoulders of these holes, thus giving positive seating regardless of the angle of the instrument.

METHOD OF MAKING MEASUREMENTS

To take a reading, the tape is reeled out and clamped at the proper hole. The operator then holds the contact ball on the dial gage spindle firmly in its socket with one hand and, grasping the scale handle with the other, aligns the instrument and applies the desired tension to the tape. His assistant at the other end of the tape merely holds the tape contact ball firmly in its socket and sees that proper alignment is secured.

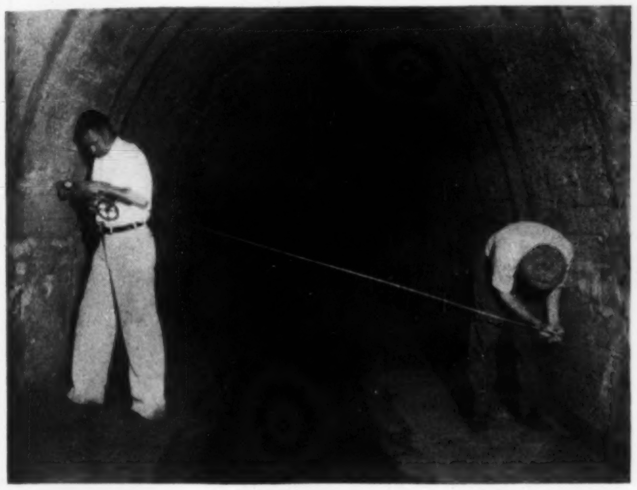
Considerable skill is required on the part of the operator to align the instrument properly, apply exactly the right tension to the tape, keep the contact point firmly in its socket, and read the dial gage. Most operators, however, become proficient after a few days of practice and are able to obtain steady and consistent readings. Different readers check each other closely, the personal factor being unimportant. The most difficult feat in handling the instrument is the maintenance of a constant tension. This is facilitated by using a scaffold or support for the operator, which permits him to brace himself near the reference point in such a manner that the arm holding the instrument is steadied against his body. With a convenient scaffold, a series of good readings can be taken faster than one a minute, even when the length of tape is changed for every reading.

Sources of error have been carefully considered and

TAKING MEASUREMENTS IS FACILITATED BY THE USE OF A SCAFFOLD
Here the Change in Length of a Diagonal Chord Is Being Determined

eliminated as far as possible. With an invar tape, temperature corrections become negligible, being less than 0.001 in. for any normal temperature change. The hardened steel contact ball and sockets show no wear after several thousand readings. The tape-clamping device gives constant and accurate settings of the tape, and errors due to imperfect alignment are practically eliminated by the alignment guides. There are, however, two sources of error that seem to be the limiting factors on the accuracy of the instrument. The first of these is due to imperfect control of tension in the tape. A deviation of 1 lb from the standard pull causes an error of about 0.005 in. in a reading. With this variation it is found that operators can control the tension closely enough to duplicate readings consistently to within 0.002 in. for chord lengths of 10 to 20 ft, and somewhat more closely on shorter lengths. An accuracy of about one in 100,000 is thus obtained.

A second source of error is introduced when it becomes necessary to take the instrument apart for repairs, cleaning, or replacement of parts. Calibrating bars are provided by which the distance between adjacent holes, the change in length of 8-in. sections of the tape, or the change in dial gage readings for a constant distance between clamp and contact ball may be found. Errors due to alterations should thus be eliminated, but it is found that the overall length of the tape may change enough to affect a reading and still not be discernible in the calibration of the short sections. A piece of invar rod supported by a light structural steel section and set up at a convenient location would make a satisfactory standard for checking the overall length of the tape. With this precaution an accuracy of one in 100,000 could be relied upon.



Another View of the Extensometer in Use
This Photograph Was Made in a Large Storm Drain

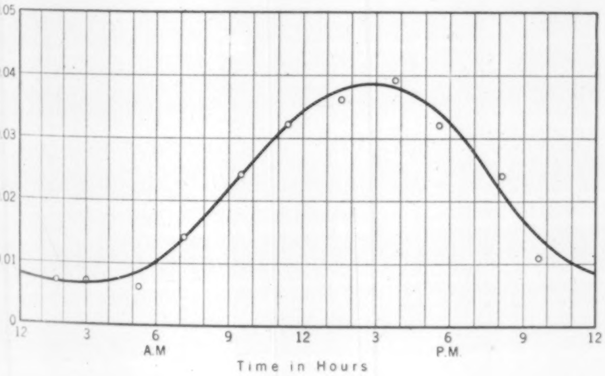
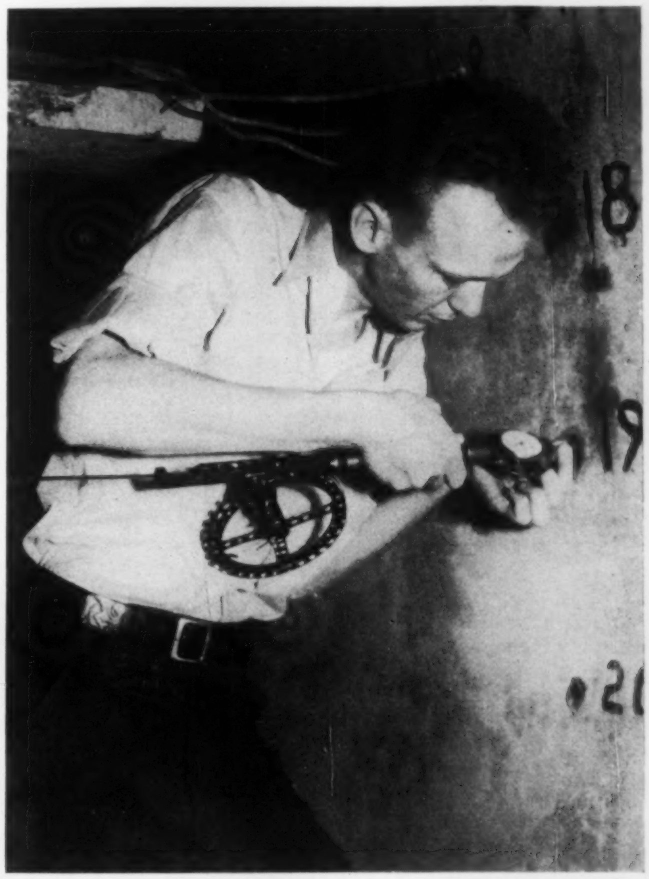


Fig. 3. Typical 24-Hr Series of Extensometer Readings
Made on the Middle Horizontal Chord of a Conduit Before Backfilling. The Strains Represent Temperature Changes Due to Exposure of the Conduit to Sunlight



Skill Is Required to Operate the Extensometer
The Operator Must Align the Instrument Properly, Apply Exactly the Right Tension to the Tape, Keep the Contact Point Firmly in Its Socket, and Read the Gage

EXTENSOMETER PROVES OF VALUE

In Fig. 3 the type of data secured with the extensometer is illustrated. The curve shows the changes in length of the middle horizontal chord of a conduit section during a 24-hr period before backfilling. These data were obtained by three parties working in 8-hr shifts. The observed strains are due to variations in the temperature of the concrete caused by direct exposure to the sun. Examination of the curve gives a good indication of the accuracy and consistency that may be expected of the instrument.

The success of the invar-tape extensometer on the work for which it was designed indicates that the instrument has a great potential field of application in the investigation of strains and, through them, of stresses, in many different types of engineering structures. An instrument as flexible in range and at the same time as exact in reading as this undoubtedly can be applied to the solution of many experimental engineering problems to which there is as yet no satisfactory answer.

The authors wish to make acknowledgment to R. E. Davis, M. Am. Soc. C.E., professor of civil engineering at the University of California, at whose suggestion the development of the instrument was undertaken.

Safety on the Colorado River Aqueduct

Accident Toll on Project Kept Low by a Variety of Safety Measures

By T. W. Osgood

Associate Member American Society of Civil Engineers
Safety Engineer, The Metropolitan Water Distrct of Southern California, Banning, Calif.

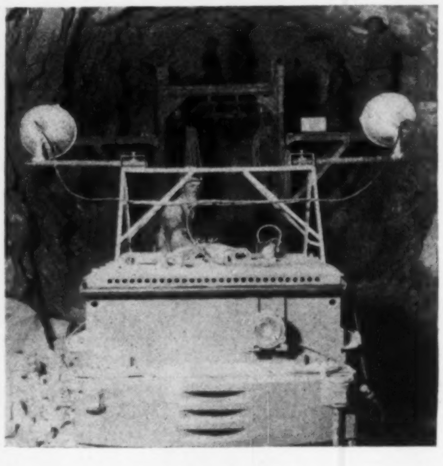
TUNNELING operations on the huge Colorado River Aqueduct project are being carried through much blocky and unstable ground by employees of whom many have had little or no previous underground experience. Nevertheless, while the number of men employed steadily increased in 1935, the number of accidents per million man-hours worked that year was 42 per cent below the 1934 record and 11 per cent below the state average for tunnel construction. This reduction in accident frequency evidences the value of measures for the safety of employees adopted by the Metropolitan Water District and carried out under Mr. Osgood's direction. Among the features of the successful safety program may be mentioned extreme care in handling and storing explosives, the extensive use of safety primers and the latest blasting equipment, the provision of good track, good hauling equipment, adequate light and air, and training in safe practices and first aid.

An excellent safety record is being made by the construction forces on the Colorado River Aqueduct, being built by the Metropolitan Water District of Southern California. The main aqueduct extends a distance of 242 miles across desert and mountains to carry the waters of the Colorado from Parker Dam to a terminal reservoir near the eastern margin of the coastal plain. It will have a capacity of 1,605 cu ft per sec, or approximately one billion gallons per day. The magnitude of the work is indicated by the fact that 66 miles of canals, 92 miles of 16-ft tunnels, 28 miles of pressure pipe lines, and 56 miles of conduits will be required for the aqueduct proper; and 16 miles of tunnels, 7 miles of conduits, and 126 miles of pipe lines for the 149-mile distribution system. Preparatory to this work, it was necessary for the District to construct and place in operation 150 miles of surfaced highways, 448 miles of high-voltage electric transmission lines, 285 miles of telephone lines, and 180 miles of water supply mains.

The tunnel and surface work on the project is being prosecuted by 20 contractors and 2 force account units of the District. The District's policy is that every possible safety measure shall be practiced, but only the splendid cooperation of the construction force has made a good safety record possible.

The thought of safety is kept constantly before the men by various expedients. Safety committees, composed of representatives of the engineers, employers, and employees, hold an average of 40 meetings each month, at which ways and means of realizing safe physical conditions and safe practices are discussed and adopted. Bulletin boards which are serviced with posters and bulletins at weekly intervals are used to remind the men; and literature on this subject published by the U. S. Bureau of Mines, the National Safety Council, and other recognized authorities is made available.

Records are kept of the causes, frequency, severity, and cost of accidents, and these serve as a valuable guide and stimulus to accident prevention. Inter-camp safety contests are a continuous feature of the safety work, with monthly and annual awards for the lowest lost-time accident frequency. A flag is awarded in the monthly contests and a banner at the end of the year.



Electric Battery Locomotives Provide Light After Normal Circuits Are Removed in Preparation for Blasting

FIRST-AID TRAINING PROVES VALUABLE

First-aid training is conducted annually in the aqueduct camps by the U. S. Bureau of Mines, and additional training is given by the safety division of the Metropolitan Water District and by the compensation insurance companies. The attendance of the men at these classes is voluntary but is most gratifying, reaching 100 per cent in a number of cases. Contests are held at intervals and prizes are awarded. The knowledge acquired through first-aid training has been used to good purpose in cases of emergency, but it is believed that the greatest benefits lie in the understanding which the men get of the consequences of injuries, thus making them more safety-minded and more diligent in protecting themselves and their co-workers from injury.

First-aid supplies and stretchers are kept in suitable cabinets near the headings and at other convenient points. On each shift a large proportion of the men have received first-aid training. First-aid stations in charge of trained nurses are located near the tunnel portals, and hospitals with highly trained staffs and excellent equipment are placed at strategic points.

A mine-rescue station is maintained by the District under the direct supervision of the safety division. This consists of an enclosed truck, ten sets of oxygen-breathing apparatus, and other mine-rescue equipment. Six 5-man rescue squads trained by the U. S. Bureau of Mines are kept intact and are available at any time in case of a tunnel fire or other major emergency at any point on the aqueduct.

HANDLING AND STORAGE OF EXPLOSIVES

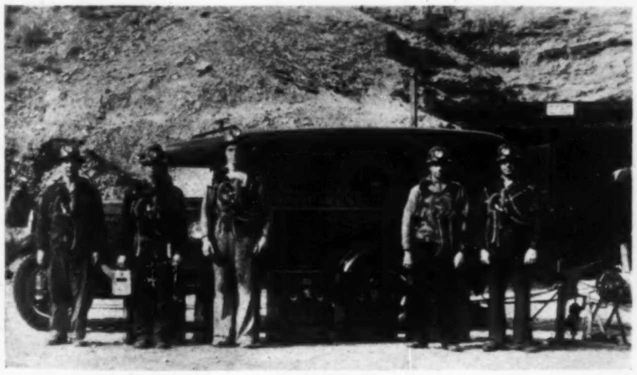
Approximately 18,000,000 lb of explosives will be consumed in blasting the 92 miles of tunnels through the mountains, and 10,000,000 lb in the construction of canals, pipe lines, and other units. With such a large potential source of danger, every safeguard is thrown around the storage, transportation, and use of these materials. Well-ventilated fireproof and bulletproof magazines are provided for the separate storage of dynamite and blasting caps, and for the operations incident to the making of primers and the splitting of dynamite cartridges. These magazines are located at least 100 ft apart and at safe distances from construction operations, buildings, highways, and railroads. In general, two types are used—the tunnel type, which as the name implies is cut into the side of a hill, and the house type, which consists of double corrugated sheet-steel walls and roof with an earth filler 1 ft thick. Suitable trucks for transporting the explosives display red flags and signs at both ends, and signs on the sides.

Safety primers are used exclusively in the blasting at tunnel headings on District work, and to a considerable extent on contract work. During the period from June 1, 1934 to October 29, 1935, more than 750,000 primers were fired, with satisfactory results as to safety and efficiency. These safety primers, described in detail on page 29 of the January 1935 issue of CIVIL ENGINEERING, consist of electric blasting caps inserted into longitudinal holes bored through wooden plugs. The plugs are manufactured on an automatic machine designed and constructed by the District forces, which has a capacity of 4,500 plugs in an 8-hr shift. Dynamite and primers are kept separate until loading operations are begun, and are transported from the magazines to the tunnel headings in separate powder cars or in two-compartment powder and primer cars. Electric-battery or trolley-type locomotives are used exclusively for tunnel hauling.

LATEST TYPE OF ELECTRIC BLASTING EQUIPMENT USED

Permanent 440-v blasting lines of No. 8 American Wire Gage rubber-covered or weatherproof wires are run on insulators on the opposite side of the tunnel from all other electric circuits and pipe lines. They are placed at least 5-in. apart and not less than 8 ft above the tunnel floor, and are kept clear of all contacts except at points of suspension. Separate 2,300/440-v, 5-kw transformers are provided exclusively for blasting, with fused switches for the protection of blasting circuits, and are located between 1,500 and 3,000 ft from the face of the tunnel.

A master blasting switch of the double-pole, double-throw type is placed opposite the transformer. This switch is normally held in the "off" position by a suitable spring attached to the handle on the outside of the switch box. In this position, the two wires are short-circuited but not grounded. This switch is so arranged that it cannot remain in the "blasting" position when the handle is released, and the line clips are provided with arc quenchers.



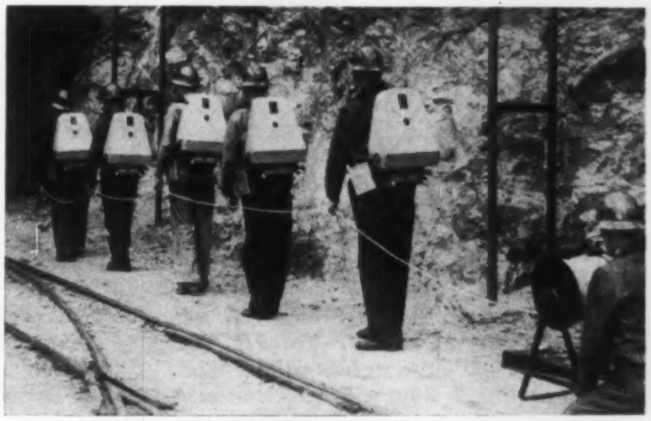
A MINE RESCUE STATION INCLUDES A SQUAD OF FIVE TRAINED MEN, AN ENCLOSED TRUCK, AND MISCELLANEOUS EQUIPMENT

Ten Sets of Oxygen-Breathing Apparatus and Other Rescue Equipment Are Provided

A safety switch similar in type to the blasting switch, but not equipped with a spring, is located not less than 500 ft back from the face of the tunnel. When in the "off" position, the two wires of the circuit are short-circuited but not grounded. Lead wires are of No. 16 American Wire Gage, single-conductor, rubber-covered wire, and bus wires of No. 16 American Wire Gage bare copper.

MISCELLANEOUS OPERATING PRACTICES MAKE FOR SAFETY

The track and all compressed-air, ventilating, and water pipes, and other lines capable of conducting electricity are bonded at 1,000-ft intervals and effectively grounded. Tunnels are normally illuminated from 110-v electrical circuits, but during loading and connecting up of a round, these circuits are removed from the heading and all electrical energy is cut off not less than 500 ft from the face. During this period, illumination is provided by flood lights, equipped with 300-w lamps, which are plugged into the circuit of an electric-battery locomotive stationed about 100 ft from the face.



ONE OF THE RESCUE SQUADS ENTERING A TUNNEL DURING PRACTICE MANEUVERS

Six Five-Man Squads Are Kept Intact at All Times

There are a multitude of other operating practices which are followed in the interest of greater safety. Protective hats are worn by all men in tunnels under construction. Switch frogs and guard rails are blocked to prevent men's feet from becoming caught in them. Automatic car couplers are used extensively. The moving parts of machines are guarded to prevent personal contact and consequent injury. Grinding wheels are equipped with tool rests, guards, and push-button control, and operators are required to wear goggles. Elevated platforms and runways are guarded by substantial railings. The use of hard-toed shoes and safe clothing, and good welding equipment and practices receives attention. Measures have been adopted for dust abatement, ventilation, tests and analyses of tunnel air, sanitation, and fire prevention.

The good physical conditions on the work have contributed considerably to the general safety, but experience indicates that the credit for minimizing the number and severity of accidents on this project is due chiefly to the development of the safety spirit within the entire organization.

F. E. Weymouth is general manager and chief engineer of the Metropolitan Water District of Southern California; J. L. Burkholder, assistant general manager; Julian Hinds, assistant chief engineer; James Munn, general superintendent (all Members Am. Soc. C.E.); and J. M. Gaylord, chief electrical engineer.

Canalization of the Upper Mississippi

Improvement by U. S. Engineers from St. Louis to Minneapolis Is Mainly for Navigation

By E. L. Daley

Member American Society of Civil Engineers

Colonel, Corps of Engineers, The Army War College, Fort Humphreys, Washington, D.C.

With the improvement of the Upper Mississippi River now under way, a minimum depth of 9 ft for navigation will be assured from its lower end near St. Louis, as far north as Minneapolis. To accomplish this a comprehensive plan has been developed, as so well described in this article by Colonel Daley; it requires 26 locks and dams forming a series of pools and involving a prospective expenditure of $150,000,000. Most of the locks are already completed or virtually so, but only six of the dams have been finished. Improving on previous European and American practice, the U. S. Army engineers have developed a submergible roller type of gate, reaching an extreme size of 26 ft in diameter by 100 ft in length and weighing 200 tons. This paper, originally presented before the St. Louis Section on May 27, 1935, gives interesting and important information on the planning of this great work, and an insight into the problems involved in its major engineering details.

Upper Mississippi River is the name applied to that part of the waterway above the mouth of the Missouri River, 15 miles upstream from St. Louis, Mo. (Fig. 1). From its source near Lake Itasca in north-central Minnesota to the junction with the Missouri River, the Mississippi River is 1,170 miles in length and has a drainage area of 171,500 sq miles. Below the falls of St. Anthony at Minneapolis (658 miles above the mouth of the Missouri) the stream flows through a flood plain varying in width from a half mile to five miles and bordered by steep bluffs. The width of the plain generally increases downstream. The river follows a winding course with many secondary channels and sloughs. The banks are generally low and subject to overflow during flood stages. The natural river slope between Minneapolis and the mouth of the Missouri averages about 0.45 ft per mile. It is generally uniform except for rapids at Le Claire, Iowa; Rock Island, Ill.; and Keokuk, Iowa. Outstanding hydrological characteristics of the Upper Mississippi are regularity of the streamflow cycle, infrequency of sudden rises of magnitude, and relatively low flood stages.

An improvement program is being prosecuted to assure a channel depth of 9 ft in the Upper Mississippi River as far upstream as Minneapolis, Minn., in accordance with congressional authorization contained in the River and Harbor Act of July 3, 1930. The increased depth above Alton, Ill., is to be obtained primarily by canalization. Canalization will convert the river into a series of pools maintained by dams provided with locks.

PROJECT VIEWED AS A WHOLE

Plans outlined in House Document 137, Seventy-Second Congress, first session, proposed improvement by means of 27 locks and dams supplemented by dredging. Subsequent studies indicated the advisability of changing the location and composition of the structures and of replacing three low-lift dams in the section of the stream from Louisiana, Mo., to Cap au Gris, Mo., with two higher structures. The plan of improvement now includes 26 locks and dams (Fig. 1), of which those previously constructed at Minneapolis, Hastings, and Keokuk are designated as Nos. 1, 2, and 19, respectively.

The navigation system also includes six headwater reservoirs located above Minneapolis, Minn. These were constructed in accordance with the River and Harbor Act of 1880, and subsequent legislation, as aids to navigation. The combined usable capacity of the reservoirs under existing operating regulations is about 1,460,000 acre-ft. By the use of reservoir water to supplement natural low-water discharges, sufficient flow is assured to supply the losses due to evaporation from the pools and to lockage and leakage at the navigation structures. The 26 locks and dams, with an aggregate lift of 331.3 ft at extreme low water, will create pools in the 650 miles of river between Alton, Ill., 8 miles above the Missouri River, and the Northern Pacific Railway bridge in Minneapolis, Minn. (Fig. 1). The pool of Dam 26 at Alton, Ill., in addition to providing a 9-ft navigable depth in the Mississippi as far as Cap au Gris, Mo., the site of Dam 25, will ensure similar depths in the Illinois River for 80 miles. The present status of construction of the various locks and dams as of June 30, 1935, is indicated in Table I.

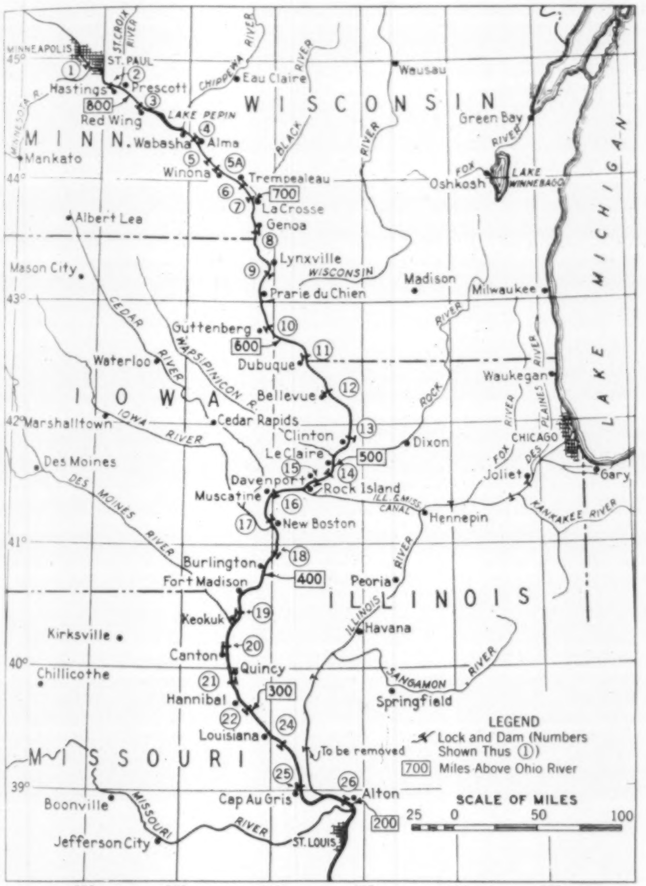
Existing riparian improvements increase the difficulties of providing pool conditions by any but low dams. Railroads, particularly above the mouth of the Wisconsin River, occupy both banks of the stream at elevations only slightly above flood stages. Throughout the entire section below Minneapolis, structures and valuable agricultural lands are found at elevations below flood stages. Below Muscatine, Iowa, there are numerous levees built for the protection of riparian property subject to inundation at high water. Lands belonging to the Mississippi Wild Life and Fish Refuge occupy most of the bottoms between Lake Peipin and the Wisconsin River. In this northern latitude, ice introduces problems in pressures on structures, in difficulties of lock and

General View of Dam No. 4 and Locks at Alma, Wis.
Taken from Top of Bluff; Embankment at Farther End

dam operation, and in the necessity of affording ample clear openings at dams to permit the free passage of running ice.

SOME DETAILS OF THE LOCKS AND DAMS

The typical dam comprises several roller gates, Tainter gates, a concrete overflow section, and varying lengths of earth dike. The roller-gate section placed in the main channel has sufficient discharge capacity for ordinary regulation. Tainter gates occupy the remainder of the main channel and pass normal flood water. A fixed overflow weir with crest at upper pool level has been employed in many instances to complete the required discharge area for passing the maximum flood. An earth embankment generally ties the structures to the bluffs, as at Alma, Wis.


MINNEAPOLIS
ST. PAUL
ST. CROIX RIVER
CHIPPEWA RIVER
Eau Claire
BLACK RIVER
Wausau
Hastings
Prescott
800
Red Wing
MINNESOTA R.
LAKE PEPIN
WISCONSIN
Green Bay
FOX RIVER
LAKE WINNEBAGO
Oshkosh
MINN.
Wabasha
Alma
Mankato
Winona
Trempealeau
LaCrosse
700
Genoa
Albert Lea
Lynxville
WISCONSIN
Madison
Milwaukee
LAKE MICHIGAN
Mason City
Prarie du Chien
CEDAR RIVER
WAPSIPINICON R.
Guttenberg
600
Dubuque
Waterloo
IOWA
Bellevue
Cedar Rapids
ROCK RIVER
Waukegan
Marshalltown
IOWA RIVER
Clinton
Dixon
CHICAGO
LeClaire
500
DES PLAINES RIVER
FOX RIVER
Des Moines
Davenport
Rock Island
Joliet
Gary
DES MOINES RIVER
Muscatine
ILL. & MISS. CANAL
Hennepin
KANKAKEE RIVER
New Boston
Burlington
Fort Madison
400
Peoria
ILLINOIS
ILLINOIS RIVER
Keokuk
Havana
Kirksville
Canton
Quincy
Chillicothe
SANGAMON RIVER
Hannibal
300
Springfield
Louisiana
To be removed
MISSOURI
Cap Au Gris
Alton
Boonville
MISSOURI RIVER
Jefferson City
ST. LOUIS
200
LEGEND
Lock and Dam (Numbers Shown Thus ①)
700 Miles Above Ohio River
SCALE OF MILES
25 0 50 100
45°
44°
43°
42°
41°
40°
39°
93°
92°
91°
90°
89°
88°
1
2
3
4
5
5A
6
7
8
9
10
11
12
13
14
15
16
17
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20
21
22
24
25
26

Fig. 1. Map of Upper Mississippi, with Canalization Improvements and Connecting Waterways

Individual dams vary considerably in composition (Table I). Each site has been treated as a separate problem. Dams Nos. 1, 2, and 19, which were constructed prior to the authorization of the canalization project, do not conform to the typical lock and dam. Owing to the constricted area at the site, Dam No. 15 at Rock Island, Ill., is composed entirely of roller gates. The gates at this site were placed in echelon formation primarily because of foundation conditions.

Mass concrete construction is used in both locks and dams. At the majority of the sites, bedrock is not within practical reach for foundation purposes. Wood piles have been generally used for the support of structures, although concrete piles are employed in special cases of poor foundations or concentrated loads. Steel H-piles are utilized where conditions warrant. Steel sheet-pile cut-offs are driven at the heel of the dam and downstream end of the stilling basin to increase the percolation distance and, in the case of the downstream cut-off, to protect against undermining.

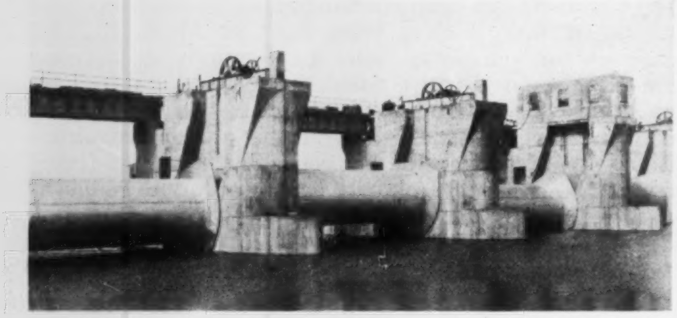
The size of lock adopted conforms to the standard for the Ohio and Illinois rivers, 110 ft wide by 600 ft long in the clear. At Rock Island, Ill., an additional lock 110 by 360 ft has been constructed as an auxiliary. A similar auxiliary lock is being built at Alton, Ill. At each of the remaining new dams, provision is being made for the eventual construction of a second lock by including the upper lock gate of this second lock and its corresponding river-wall bay in the original construction. Lock gates are of the vertically framed mitering type. Downstream lock sills are in general at an elevation of 11 ft or more below the crest elevation of the dam below, and upstream lock sills are 15 ft or more below the upper pool elevation. Locks are filled and emptied by means of longitudinal culverts in the bases of the walls, the flows in which are controlled by Tainter valves in each end of each culvert.

Physical conditions on the Upper Mississippi render advisable the use of relatively low dams with spillways of such capacity that flood stages will not be materially affected. The non-navigable type of dam, with gates that can be raised clear of the water, although greater in first cost, has been found more suitable for the Upper Mississippi than navigable dams of the Ohio River type, which can be lowered to permit navigation to pass over them. The non-navigable type positively controls the pool. It is less hazardous to operate and is more dependable. Under open-river conditions, adequate navigable depths are not generally available for sufficiently prolonged periods to encourage the use of dams of the navigable type. The relatively low flood stages of the Upper Mississippi are favorable to low-cost construction of the type of dam selected. Low flood stages allow lockage of vessels at nearly all stages without involving excessive heights of lock walls.

IMPROVED ROLLER GATES DEVELOPED

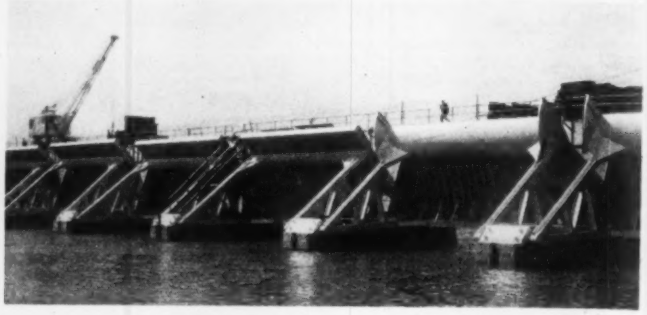
Various types of crest gates were investigated in connection with controllable spillways for the dams. The adopted combination of roller and Tainter gates was found to offer the best assurance, at reasonable cost, of dependable operation with a maximum of clear discharge opening between piers. Gate sills are being placed at the lowest practicable elevations in order to provide large discharge capacity per unit length of spillway. Recesses in both the upstream and downstream ends of the piers provide for the installation of bulkheads to allow emergency unwatering of the spillway gates.

Roller gates have had extensive use in Europe but are comparatively new in this country. The non-submergible type of roller gate installed on the Upper Mississippi River consists of a large steel cylinder or drum with a projecting apron which rests on the sill in the closed position. The diameter of the drum is approximately three-quarters of the total height of the gate. The top of the drum is at the level of the pool while in the closed position. The diameter of the cylinder is partially governed by the necessity for rolling the bottom of the gate clear of high water. The skin plating of the drum is kept in cylindrical shape by internal bracing consisting of structural-steel cross-frames and longitudinal channels. At each end, inside the cylinder, is a solid heavy disk or diaphragm to transfer the loads to the piers. Attached to the outside of the drums at these points are heavy cast-steel rings containing rugged specially formed teeth, which engage with similar teeth on inclined racks located in recesses in the piers. The gate is hoisted by means of a multiple side-bar chain extending from the hoisting machine to one end of the drum. With the gate in the lowered position, the chain practically surrounds the drum, adjacent to the ring. The chain unwinds as the gate rises and is automatically racked up in a recess in the top of the pier.



ERECTING SUBMERGIBLE ROLLER GATES AT DAM NO. 5

Structures at Fountain City, Wis., Are 60 Ft by 20 Ft in Diameter. Operating Machinery, Above, Will Later Be Completely Housed



TAINTER GATES AT DAM NO. 20, CANTON, MO.

Traveling Crane Is in Use and Traveling Gate Hoist Is in Process of Being Assembled

Positive sealing at the ends of the non-submergible type of roller gates is effected by timber or rubber sealing strips bolted to end shields fastened to the drum. Corrosion-resisting steel plating is embedded in the faces of the piers to reduce friction where the sealing strips rub. The bottom of the gate is sealed by means of timber or rubber strips bolted to the apron and seating directly on a steel beam embedded in the sill. In all the roller gate installations, provision has been made for placing electrical heating units behind the steel plating on the piers. Heating elements are also placed on the inside of the end diaphragms of the gates. The units were especially developed for this service and so far as is known are the largest tubular-type heating units ever built.

The non-submergible type of roller gate has no provision for passing drift or ice except by overflow or by raising the gate sufficiently to permit it to be drawn under. The overflow method increases pool heights. Raising the gate results in undesirable loss of water during low flows as well as high velocities below the dam. To overcome these objections, submergible gates have been installed at certain of the dams already constructed. Recent experiments made at the completed dam at Rock Island have indicated the superiority of such a type of gate over the non-submergible type. It is planned to install submergible roller gates at all future Upper Mississippi River dams.

SUBMERGIBLE AND TAINTER TYPES FOUND USEFUL

These submergible roller gates employ somewhat different sealing principles from the gates of this type previously constructed. In general the gate resembles a regular roller gate except for the end shields. These are made large to shield the pier recesses when the gate is submerged. The lower part of the pier rack is curved downstream to permit the gate to drop below the sill, and the sill is shaped so that the gate may be lowered. The bottom is sealed by means of a flexible rubber strip attached to the edge of the roller-gate apron. In the normal position (top of gate level with pool) this seal bears directly against a plate embedded in the sill, but as the gate is lowered in a downstream direction the seal breaks away from the sill. The distance between the sill and the apron is relatively small, thus preventing a noticeable flow under the gate. Side sealing depends upon the same type of rubber strip attached to the end shield. By a careful selection of the position and radius of the apron and by proper shaping of the track and sill, it has been possible to get the end shield to fall behind the apron rather than in front of it as has ordinarily been the case with submergible roller gates. This arrangement obviates the necessity of cutting slots in the sill to receive the end shields, a practice which in Europe has sometimes resulted in crushing of the shields due to clogging of the slots.

The maximum submergence of the roller gates installed to date at Upper Mississippi River dams is 3 ft. Studies and designs now in progress contemplate the use of gates with a submergence of as much as 10 ft in some cases. The sizes of roller gates, either in use or contemplated, are as follows: 60 by 20 ft, 80 by 20 ft, 80 by 25 ft, 100 by 20 ft, and 100 by 26 ft. In general, the length of the roller gates is determined by the strength of the foundations. The maximum sized gates on this project, 100 by 26 ft, are in use at Dam No. 15, where rock foundations were available. Each of these gates weighs over 200 tons.

The Tainter gates in use at these dams are notable because of their dimensions. The usual maximum size of Tainter gates in this country is about 30 by 20 ft. The sizes of the gates now in use or contemplated for use on the Upper Mississippi are 35 by 15 ft, 30 by 20 ft, 40 by 20 ft, 40 by 30 ft, 60 by 20 ft, and 60 by 25 ft. Studies have shown the practicability of submergible Tainter gates, and this type has been installed at several locations. The amount of submergence of the gates constructed has been limited to 3 ft, but gates capable of being submerged 10 ft have been designed and are to be constructed. Special consideration has been given to the design of crest and spillway plating on submergible Tainter gates to overcome the problems resulting from vibration. The load-carrying members of the gate proper are inclosed between the skin and spillway plating to prevent damage from passing ice or drift.

Each roller gate is operated by an individual stationary hoist capable of raising it at a rate of approximately 9 in. per min. Tainter gates at some locations are lifted by traveling hoists moving on a service bridge. At other locations the Tainter gates as well as the roller gates will be operated by individual hoists. Power for the operation of locks and dams in the majority of cases will be secured from convenient public utility systems. At Dam No. 15 a part of the power for operation is generated by a small hydro-electric unit incor-

Table I. Summary of Data for Canalization Project, Upper Mississippi River

Dimensions in Feet Unless Otherwise Noted

Lock and Dam No.	Location, Nearest Town	Pool El. M.S.L.[1]	Lock Dimensions[2]			Spillway Section					% Completed June 30, '35		Estimated Cost Including Flowage[4]
						Roller Gates		Tainter Gates		Length of Weir			
			Width	Usable Length	Lift[3]	No.	Dimensions	No.	Dimensions		Lock	Dam	
1	Minneapolis, Minn.	723.1[5]	56 56	400 400	35.8	.	....	..	......	570	100 100	100	$1,000,539.26
2	Hastings, Minn.	687.25[6]	110[8] 110	500 500	12.3	.	....	20	30 × 20	...	... 100	100	3,857,000.00
3	Red Wing, Minn.	675.0	110	600	8.0	3	80 × 20	6	35 × 15	1,150	...	...	6,969,000.00
4	Alma, Wis.	667.0	110	600	7.0	6	60 × 20	22	35 × 15	...	100	98	4,386,000.00
5	Fountain City, Wis.	660.0	110	600	9.0	6	60 × 20	28	35 × 15	...	100	98	4,848,000.00
5-A	Winona, Minn.	651.0	110	600	5.5	5	80 × 20	5	35 × 15	1,000	100	30	4,696,000.00
6	Trempealeau, Wis.	645.5	110	600	6.5	5	80 × 20	10	35 × 15	1,000	100	36	5,404,000.00
7	La Crosse, Wis.	639.0	110	600	8.0	5	80 × 20	11	35 × 15	1,000	100	...	5,768,000.00
8	Genoa, Wis.	631.0	110	600	11.0	5	80 × 20	10	35 × 15	2,000	100	...	7,264,000.00
9	Lynxville, Wis.	620.0	110	600	9.0	5	80 × 20	8	35 × 15	1,100	100	...	6,637,000.00
10	Guttenberg, Iowa	611.0	110	600	8.0	4	80 × 20	8	40 × 20	1,200	100	16	4,865,000.00
11	Dubuque, Iowa	603.0	110	600	11.0	3	100 × 20	13	60 × 20	...	98	...	5,572,000.00
12	Bellevue, Iowa	592.0	110	600	9.0	4	80 × 20	12	40 × 20	1,000	89	...	5,557,000.00
13	Clinton, Iowa	583.0	110	600	11.0	4	80 × 20	17	40 × 20	1,300	...	...	5,985,000.00
	Le Claire canal lock[7]	...	80[7]	320	..	.	....	..	....	...	100	...	....
14	Le Claire, Iowa	572.0	110	600	11.0	.	(Not fully determined)				...	...	5,308,000.00
15	Rock Island, Ill.	561.0	110 110	360 600	16.0	2 9	100 × 21.75 100 × 26	..	......	...	100 100	100	6,418,351.62
16	Muscatine, Iowa	545.0	110	600	9.0	4	80 × 20	15	40 × 20	1,700	100	20	4,974,000.00
17	New Boston, Ill.	536.0	110	600	8.0	4	80 × 20	13	40 × 20	1,700	...	...	5,441,000.00
18	Burlington, Iowa	528.0	110	600	9.8	3	100 × 20	14	60 × 20	1,955	100	...	5,945,000.00[9]
19	Keokuk, Iowa	518.2	110[8] 110[7]	600 358	38.2	.	....	119	30 × 11[10]	...	... 100	100	2,983,000.00 [11]
20	Canton, Mo.	480.0	110	600	10.0	3	60 × 20	40	40 × 20	...	100	84	4,585,000.00
21	Quincy, Ill.	470.0	110	600	10.5	4	80 × 20	10	60 × 20	1,520	98	...	5,645,000.00
22	Saverton, Mo.	459.5	110	600	10.2	.	(Not fully determined)				100	...	5,006,000.00
24	Clarksville, Mo.	449.0	110	600	15.0	.	(Not fully determined)				...	...	6,078,000.00
25	Cap au Gris, Mo.	434.0	110	600	15.0	.	(Not fully determined)				...	...	7,290,000.00
26	Alton, Ill.	419.0	110 110	360 600	[12] 20.0	3	80 × 25	30	40 × 30	...	68 68	...	12,204,000.00

Total, locks and dams	$144,685,890.88
Other costs chargeable to 9-ft project, including dredging and regulating works, earth levee, and rock excavation in pool No. 15, rock excavation in pool No. 16	2,892,000.00
Miscellaneous	539,109.12
Grand total cost[4]	$148,117,000.00

[1] 1912 adjustment, U. S. Coast and Geodetic Survey, except Nos. 24, 25, and 26, which are 1929 adjustment. To obtain 1912 adjustment, add 0.34, 0.32, and 0.30 ft at 24, 25, and 26, respectively.

[2] Present construction makes provision for future 110 by 360-ft auxiliary lock, at all sites where single 110 by 600-ft lock is shown in this table.

[3] Based on completion of all pools to elevations corresponding to those in Col. 4.

[4] Exclusive of cost under previous projects of works incorporated into present project as follows:

Lock and dam No. 1	$3,298,330.73
Lock and dam No. 2	1,965,316.22
Le Claire Canal	540,000.00
	$5,803,646.95

[5] Pool elevation 725.1 with flashboards.

[6] Present pool; ultimate 689.15.

[7] Existing lock to be used as auxiliary.

[8] Proposed lock.

[9] Including cost of Henderson River diversion.

[10] Vertical lift gates.

[11] First lock constructed by Mississippi River Power Company in accordance with terms of power license and transferred to the federal government. Present estimate covers second lock and drydock.

[12] Lift 20 ft above possible future pool. Maximum lift of 25.2 ft at extreme low water.

porated in the river wall of the lock. At certain other sites where head conditions are reasonably favorable, provision is being made to allow future installation of hydro-electric units for operation of the navigation structures should such procedure be found desirable.

INVESTIGATIONS BEAR FRUIT

Due to the unstable composition of the stream bed, prevention of erosion below the spillways is a major problem. Certain of the proposed dams were studied by means of laboratory models to develop a suitable general type of protection. The similarity of foundation materials, composition of the dams, and methods of operation made it possible through model studies to develop criteria whereby the energy-dissipating structures could be properly designed to meet the varying requirements brought about by differences in head and in rates and distribution of spillway discharges. The adopted design consists of a depressed concrete apron extending downstream from the gate sills. This apron terminates in a raised step or still, in some cases dentated and in others solid. The river bed downstream from it is protected by stone riprap. A short distance downstream from the point on the apron where the jet takes a horizontal direction of flow, two transverse rows of concrete baffle piers are located. This composite stilling basin is designed to dissipate excess energy by means of the hydraulic jump.

Engineering studies and investigations made in connection with the project have resulted in the use of special, moderate-heat-producing portland cements. Investigation has been made of the effectiveness of electric and pneumatic vibrators in the placement and compaction of concrete having a low water cement ratio and paste content.

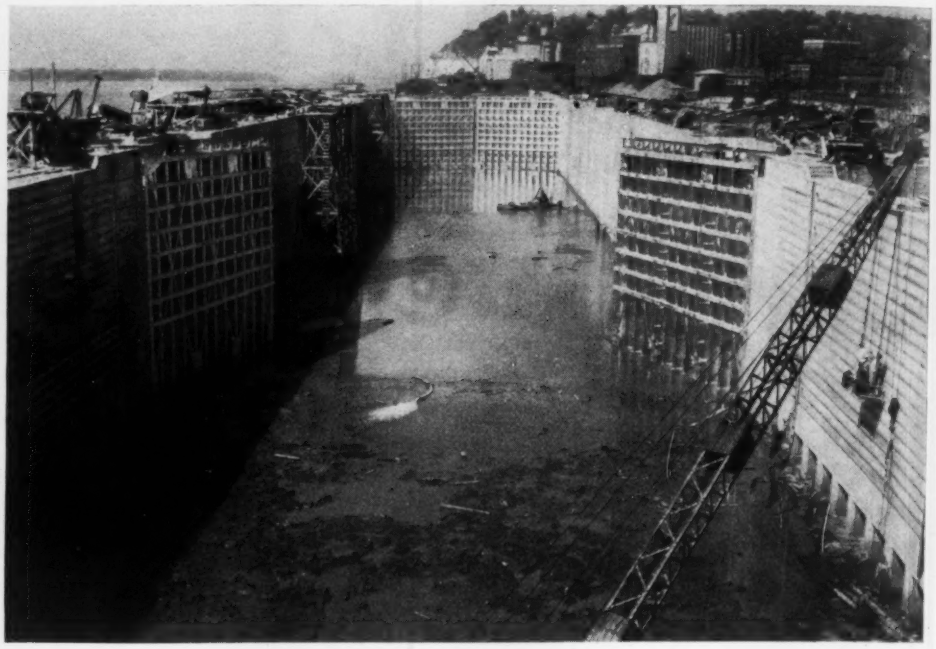
Silt ranges are being established in pools and mouths of tributaries to enable future determination of the silting effects of the canalization improvement. The Upper Mississippi River does not carry a particularly heavy silt load as compared with the Missouri or the Mississippi below the Missouri. Since the type of dam proposed for the Upper Mississippi will afford opportunity for flushing out silt that may accumulate in the pools, little difficulty is expected from silt deposits immediately above the dams. However, some maintenance dredging is contemplated.

All the major features of the Upper Mississippi River project are being constructed under contract. In order to permit uninterrupted navigation, the lock at each site is built prior to the dam, each job being handled under a contract. The general plan for the improvement, as transmitted to the Congress by the Secretary of War, contained a recommendation for a progressive program, to afford improvement first at those localities where navigation was most hampered, followed in succession by the improvement of other less critical stretches of the river until the full project dimensions were obtained.

In compliance with the recommended program, the construction of Lock No. 15 was started on April 27, 1931. Upon completion of contracts let during 1935, complete navigation facilities will exist at 16 of the 26 sites. In addition, locks will be available at 9 of the remaining 10 locations.

Amounts allocated to this project to July 1, 1935, total approximately $90,800,000. Of this sum about $13,800,000 came from regular river and harbor funds, $52,000,000 from Public Works Administration funds, and $25,000,000 from the Emergency Relief allotment. The desire to expedite construction of the canalization project in order to provide employment and to aid in business recovery has to some extent necessitated abandonment of the original sequence of construction.

In addition to the primary objective of securing a dependable 9-ft channel for navigation, other important benefits will result from the canalization of the Upper Mississippi. Water levels at existing wild life and fish refuges are stabilized. An increase in head increases the power available at the existing water power plants in the vicinity of Rock Island, Ill. One of the important incidental benefits is the opportunity afforded residents of the surrounding regions to utilize the pools created by the dams for recreational purposes. An active interest in the future recreational possibilities of pool No. 26 is now being displayed by the St. Louis Regional Planning Association. It is anticipated that other organizations of a similar nature will become interested as the project nears completion. The Corps of Engineers and the U. S. Bureau of Fisheries in 1930 co-operated in a survey bearing on fishery problems in various sections of the upper river. It was found that the controlled pool may be made to increase fish production and to better fish conditions.



CONSTRUCTION VIEW OF LOCK NO. 26, AT ALTON, ILL.
View Upstream from Railroad Bridge

The execution of the canalization project is under the general direction of the Division Engineer, Upper Mississippi Valley Division, U. S. Engineer Department, St. Louis, Mo. The District Engineers of the U. S. Engineer Offices at St. Paul, Minn., Rock Island, Ill., and St. Louis, Mo., are directly responsible for the prosecution of those parts of the project which are in their districts.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Charts for the Design of Concrete Mixes

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THE charts herein described were devised to provide a simple, unified procedure for the design and checking of concrete mixes. They should make it easy to visualize the relations between the variables of any 1-yd mix. They give readings producing results well within a relative error of 1:100, and since the average job still presents the problem of obtaining accurate control in the measurement of aggregates and their free-water content, the value of greater accuracy in the design and field checking of concrete mixtures must be open to question.

Figure 1 assumes the weights of aggregates, surface-dry and rodded, to be 110 lb and 100 lb per cu ft for fine and coarse respectively, while Figs. 2 and 3 assume the apparent specific gravities of both fine and coarse aggregates to be 2.65 and that of cement to be 3.10. Objections to this feature of the charts are answered hereinafter.

Figure 1 gives the approximate percentage of sand, by weight, in the total aggregate when the proportions of fine aggregate to coarse, by dry rodded volumes, are given or assumed. This percentage need be only approximate; the chart is intended only for preliminary calculations of trial mixes.

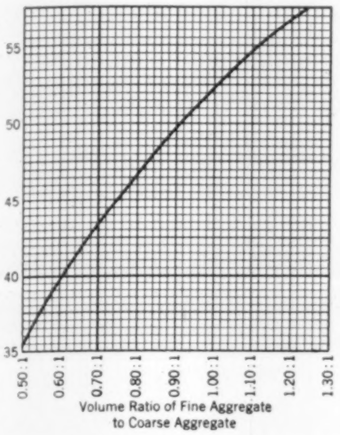

FIG. 1. PERCENTAGE OF TOTAL AGGREGATE CONSISTING OF SAND FOR GIVEN VOLUME RATIOS OF FINE TO COARSE

Sand and Stone Are Assumed to Weigh Respectively 110 and 100 Lb per Cu Ft, Surface-Dry and Rodded

Figure 2, based on the familiar absolute-volume formula, shows the relations existing, in 1 cu yd of concrete, among the three variables of any mix—cement, aggregate, and water. This chart is in line with the trend toward specifying the ingredients of a concrete mix by fixing the minimum number of sacks of cement per cubic yard and the maximum number of gallons of water per sack of cement, and leaving to the inspector the proportioning and the determination of the amount of aggregates necessary to attain the required workability with the greatest economy. The chart obviates the necessity of first expressing a mix in volume proportions, as 1:2:4, and then, by means of unit weights and apparent specific gravities, obtaining the absolute volume produced by one sack of cement.

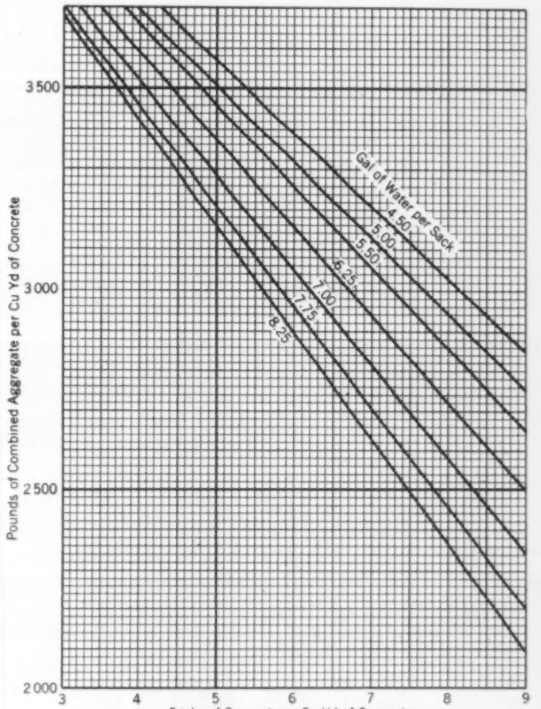

FIG. 2. QUANTITIES OF MATERIALS FOR 1 CU YD OF CONCRETE, AGGREGATES SURFACE DRY

Specific Gravity of Aggregates Taken to Be 2.65

On a job where the nature or extent of the work does not permit or justify checking accurately the specific gravities of the aggregates, and where water control is on an approximate basis, sufficiently accurate results can be obtained directly from Fig. 2. Refinements can easily be made, however, when the specific gravities of the aggregates are known, by applying the correction factor, $\frac{0.377CF}{P(C-F)+F}$, in which C represents the specific gravity of the coarse aggregate; F, the specific gravity of the fine aggregate; and P, the percentage by weight of fine aggregate in the total aggregate, expressed as a decimal. The specific gravity of cement can vary 4 per cent from the assumed figure of 3.1 before an error greater than 1 per cent appears in the recorded weights of aggregates.

Figure 3 enables one to determine the quantities required to produce 1 cu yd of concrete for any mix of known water-cement ratio. It is best explained by an example. Assume that the mixer is being charged with a batch consisting of 7 sacks of cement, the damp equivalent of 3,400 lb of dry aggregate, and a total of 6.25 gal of water per sack of cement. How many sacks of cement are being used per cubic yard of concrete produced? From Fig. 2, a 7-sack mix, with 6.25 gal of water per sack, requires 2,930 lb of aggregate to produce 1 cu yd of concrete. Our batch mix has 470 lb of additional aggregate. Entering Fig. 3 at 470 lb, and reading the graph of "Increased Aggregate," we obtain the conversion factor of 0.905. Multiplying the terms of the batch mix by this factor, we find we are using 6.335 sacks of cement and 3,077 lb of aggregate per cubic yard. Figure 2 will verify the correctness of these calculations. It must be noted that when the correction factor for specific gravities other than 2.65 is being used, the actual weight of aggregate in the batch under consideration must be divided by this factor before subtracting the weight read in Fig. 2.

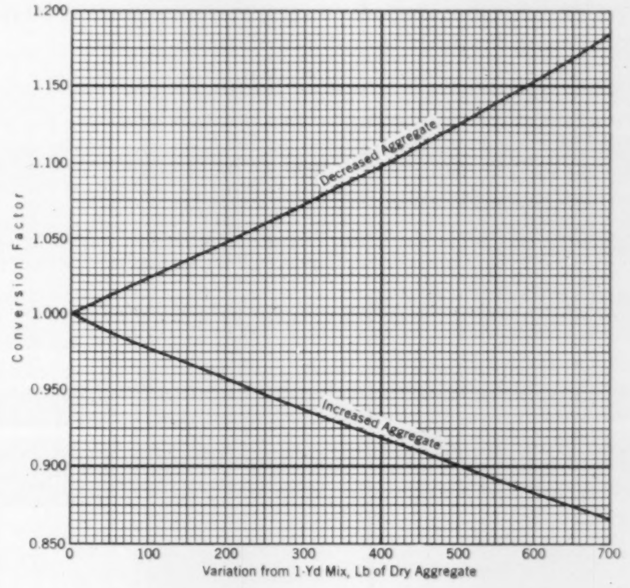

FIG. 3. FACTORS FOR CONVERTING BATCH QUANTITIES TO QUANTITIES PER CUBIC YARD OF CONCRETE

To Be Used in Conjunction with Fig. 2

Figure 4 gives the factor for obtaining the weight of damp aggregate that is required to equal a desired weight of dry aggregate when the moisture content, expressed in gallons per 100 lb of damp aggregate, is known. This moisture content must be measured, regardless of the method of design, to determine the amount of free surface water in the aggregate, and the chart merely permits the use of the value already obtained. The required weight of damp aggregate equals the desired weight of dry aggregate times the conversion factor.

The charts can be used just as effectively on jobs where the batch proportioning is done by volume measurement. After the designed mix has been expressed in damp weights, all that is further required is a field test of the weight of 1 cu ft of each aggregate, measured damp and loose. (This step is required even though the mix is expressed and calculated from volume proportions.) The total damp weights divided by these unit weights will give the required batch volumes. Note that the necessity of testing for, and calculating, the bulking factor is eliminated by the use of Fig. 4 and the division by the weights per cubic foot, damp and loose.

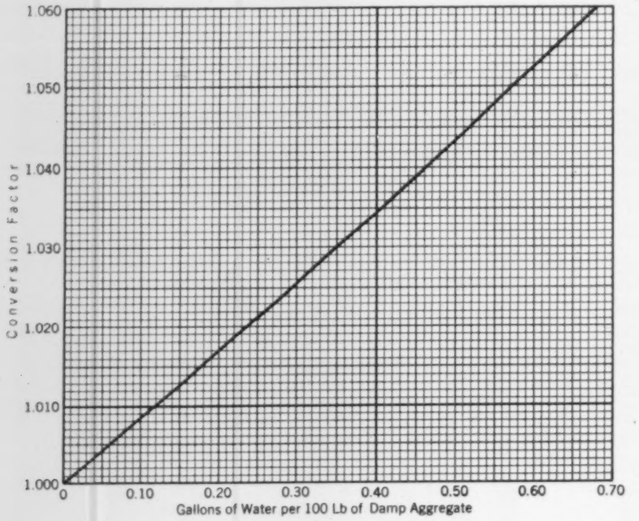

FIG. 4. CONVERSION FACTORS FOR DETERMINING WEIGHT OF DAMP AGGREGATE EQUIVALENT TO A GIVEN WEIGHT OF DRY AGGREGATE

As a typical example in the use of the charts, suppose that a mix is to be designed which will use no less than 4.8 sacks of cement per cubic yard and no more than 7 gal of water per sack. The apparent specific gravities of fine and coarse aggregate have been determined to be 2.70 and 2.95, respectively, and the moisture contents are respectively 0.40 gal and 0.25 gal per 100 lb of damp aggregate. The ratio of dry rodded volumes, arbitrarily selected and subject to change, is 0.50:1.

Our tentative design will be based on 5 sacks per cu yd. From Fig. 1, the approximate percentage, by weight, of sand in the total aggregate is 35.5. The correction factor is $\frac{0.377 \times 2.95 \times 2.70}{0.355\,(2.95 - 2.70) + 2.70} = 1.077$. From Fig. 2, the uncorrected weight of dry aggregate per cubic vard is 3,280 lb. This quantity must now be multiplied by the conversion factor to obtain the correct total weight (3,533 lb), which is divided between the sand and stone in the proportion indicated by Fig. 1 (1,254 lb and 2,279 lb, respectively). The damp weights can now be computed, by application of the factors from Fig. 4, as 1,297 and 2,328 lb, respectively. As the free surface water amounts to 11 gal (12.97 × 0.40) + (23.28 × 0.25), 24 gal of water must be added at the mixer.

Assume that the appearance of the first few batches indicates that the mix is correctly proportioned but could be of a slightly stiffer consistency without sacrificing workability. We will try adding 50 lb of damp sand and 90 lb (2328 × 50/1297) of damp stone. The revised field damp batch will require only 23.6 gal of water, since the additional aggregate contains 0.4 gal. This change in quantities of aggregate does not affect the ratio of fine aggregate to coarse, as previously read from Fig. 1. When a change is made which does affect that ratio, a new correction factor must be determined before making the following calculations.

To compute the number of sacks of cement actually being used per cubic yard in the revised batch mix, we first divide the weights of damp aggregate by the previously found conversion factors of Fig. 4. The combined dry weight of sand and stone is found to be 3,669 lb. Dividing this quantity by the correction factor (1.077) gives 3,407 lb, an excess of 127 over the 3,280-lb requirement originally read from Fig. 2. In Fig. 3, the conversion factor corresponding to this excess is found to be 0.9725, so that the actual number of sacks per cubic yard is 5 × 0.9725, or 4.86, and the number of pounds of dry aggregate per cubic yard (not yet corrected for the variation in specific gravity) is 3,407 × 9,725, or 3,313. These values can be checked in Fig. 2.

The writer wishes to make acknowledgment to Walter J. Harris, Assoc. M. Am. Soc. C.E., for his article entitled, "Concrete Quantities by Absolute Volume Method," in the August 1934 issue. It was Eq. 1 of Mr. Harris' article that suggested Fig. 2.

Comprehensive Diagram of Williams and Hazen Pipe-Discharge Formula

By ALLAN T. RICKETTS, M. AM. SOC. C.E.
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THERE is presented herewith a diagram of the Williams and Hazen formula (Fig. 1) that has proved useful in solving extensive problems involving friction losses in distribution systems. I do not know of any other diagram from which may be obtained directly the total loss of head for any given length of pipe and for various values of the coefficient C.

The diameter lines are the vertical dashed lines originating above the main body of the diagram at points where the sloping size-lines intersect the horizontal lines corresponding to various values of C. Because of their more frequent use, the diameter lines for $C = 100$ have been emphasized by heavy dashes and extended down through the main body of the diagram. Diameter lines for $C = 80$, 120, 140, and 160 are shown in light dashes extending down to the top of the main diagram; these and lines for interpolated values of C can be carried vertically downward through the main diagram when required.

The length lines are the horizontal solid lines in the main diagram, indicated by the scale at the left giving the total length of the pipe in thousands of feet.

The loss-of-head lines are the same as the length lines. The scale at the left, when used in this connection, gives the total loss of head in feet for the given length.

The discharge lines are the vertical solid lines, indicated by the scale at the bottom, giving discharge in millions of gallons daily.

The velocity lines are the light dashed lines sloping downward to the right, giving velocity in feet per second. It is important to note that these velocity lines can only be used with 1,000-ft lengths for $C = 100$.

The guide lines are the solid lines sloping upward to the right in the main diagram.

It should be noted that the complete solution of a problem is usually determined by two points on the diagram. One of these points has as coordinates the diameter and total length, and the other point, the discharge and total loss of head. Given any three factors,

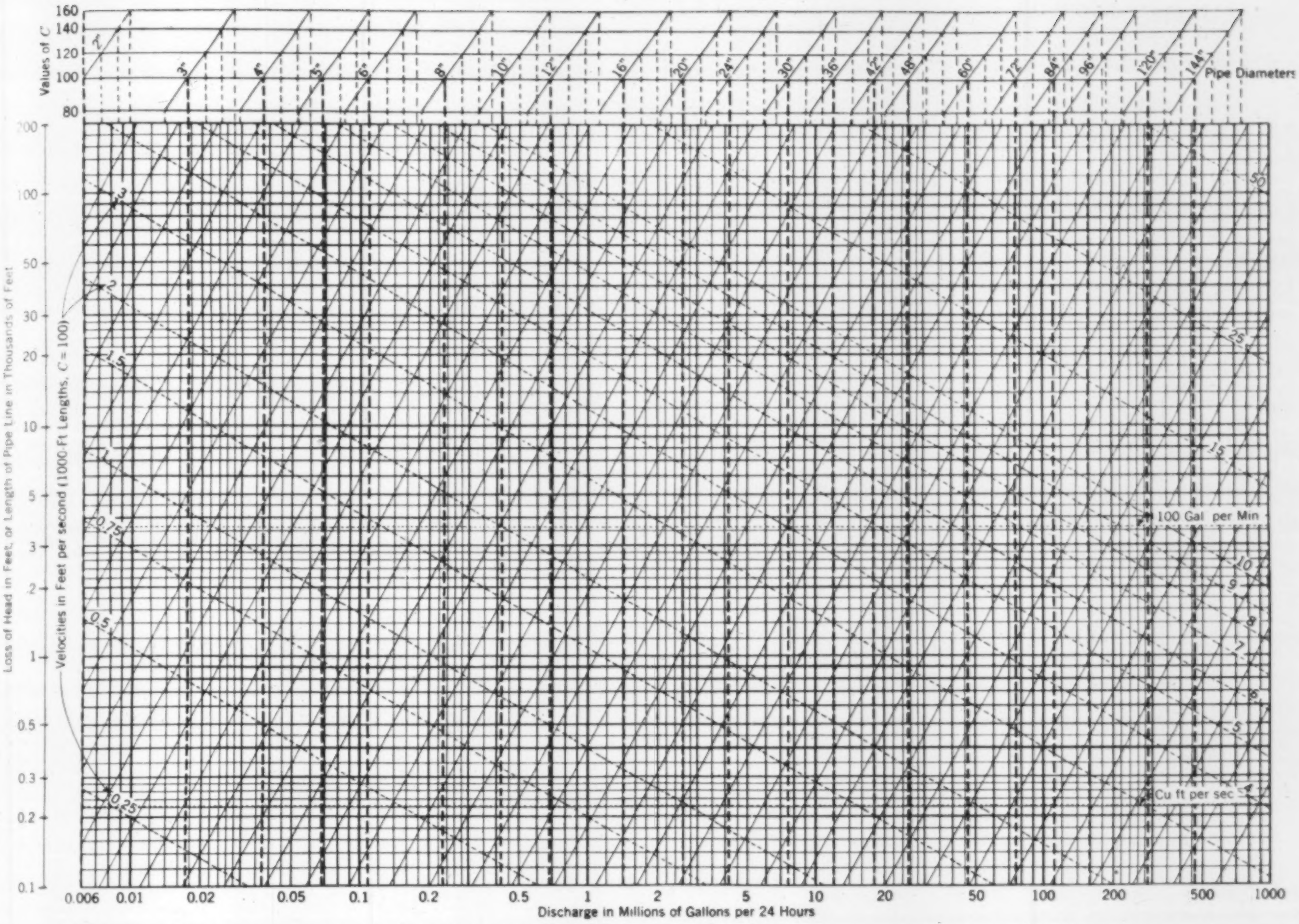

FIG. 1. DIAGRAM FOR THE SOLUTION OF PIPE-DISCHARGE PROBLEMS, BASED ON THE WILLIAMS AND HAZEN FORMULA

the fourth may be determined, for both points are always on the same guide line.

Problem 1. Given a diameter of 6 in., a length of 5,000 ft, and a discharge of 0.20 mgd, to find the total loss of head for $C = 100$. Find on Fig. 1 the intersection of the 5,000-ft length line with the 6-in. diameter line corresponding to $C = 100$. This locates the guide line for the given pipe. Then follow the guide line upward to the right to its intersection with the 0.2-mgd discharge line. The loss of head can then be read, opposite this point on the scale at the left, as 15.2 ft.

Problem 2. The data are the same as in Problem 1, and the problem is to find the velocity in the pipe. From the intersection of the 6-in. diameter line ($C = 100$) with the 1,000-ft length line, proceed upward to the right along the guide line to an intersection with the 0.2-mgd discharge line. The velocity lines are now applicable, and by interpolation the velocity is 1.6 ft per sec.

Problem 3. Given a diameter of 8 in. and a length of 3,250 ft, to find the "equivalent pipe"—that is, the length of any other size of pipe that will give the same loss of head as the given pipe line under any discharge. Find the intersection of the given length line and diameter line. Then follow the guide line upward to the right or downward to the left to the intersection with the diameter line corresponding to the desired size of pipe and value of C (herein taken as 100). For example, from the intersection of the guide line with the 6-in. diameter line, move horizontally to the scale at the left and read 0.8 (800 ft). Similarly, find 110 ft of 4-in. pipe, 9,800 ft of 10-in., etc.

Problem 4. Given a discharge of 0.75 mgd through 2,350 ft of 8-in. pipe, followed successively by 500 ft of 6-in. and 3,800 ft of 12-in. pipe, to find (*a*), the equivalent pipe, and (*b*), the total loss of head. Applying the method of Problem 3, we find the first section to be equivalent to 575 ft of 6-in pipe and the third section to be equivalent to 125 ft of the same size. A 1,200-ft length of 6-in. pipe is therefore the equivalent of the given system, and the loss of head is found by the method of Problem 1 to be 42 ft.

Problem 5. Given a total discharge of 3.3 mgd through three parallel pipes, as follows: 7,000 ft of 10-in. pipe ($C = 100$); 3,500 ft of 6-in. pipe ($C = 80$); and 1,700 ft of 12-in. pipe ($C = 140$). The problem is to find (*a*), the loss of head, and (*b*), the discharge through each branch line. The steps in the solution are illustrated in Fig. 2. First find the discharge through each line corresponding to some selected loss of head, as follows. As shown in outline in Fig. 2 (*a*), find the intersection (1) of the 7,000-ft length line with the 10-in. diameter line for $C = 100$. Then follow the guide line downward to the left to, say, the 1-ft loss-of-head line at (2); then move vertically downward and read from the discharge scale at the bottom, 0.147 mgd. Similarly, discharges for the 6-in. and 12-in. branches are found to be 0.043 mgd and 0.73 mgd, respectively. The combined discharge for a head loss of 1 ft is therefore 0.92 mgd, and the guide line through the intersection (7) of the 1-ft loss-of-head line with the 0.92 mgd discharge line is the curve of the equivalent pipe for the system. From (7), follow this guide line upward to the right to the intersection (8) with the 3.3-mgd discharge line; then move horizontally to the scale at the left and read 10.8, the loss of head in the system for the given flow. The discharge through each branch pipe can now be determined, as indicated in Fig. 2 (*b*), by intersecting the 10.8-ft loss-of-head line at points (9), (10), and (11), with the guide lines from points (1), (3), and (5) previously located as in Fig. 2 (*a*). Proceeding vertically downward from (9), (10), and (11) to the scale at the bottom, we find the discharges to be 0.54 mgd, 0.16 mgd, and 2.6 mgd for the 10, 6, and 12-in. pipes, respectively.

Problem 6. Given a length of 1,600 ft, a discharge of 2.0 mgd, and a total loss of head of 15 ft, to find the pipe size. Find on Fig. 1 the intersection of the 2.0-mgd discharge line with the 15-ft loss-of-head line; then follow the guide line downward to the left to its intersection with the 1,600-ft length line. This intersection locates the required diameter line. Proceeding vertically upward, we find that a 12-in. pipe having a value of C of approximately 90, or a 10-in. pipe with a value of C of approximately 140, will satisfy the requirements. This problem illustrates also the use of the diagram to determine the value of C for an existing pipe in which the head loss and discharge have been measured.

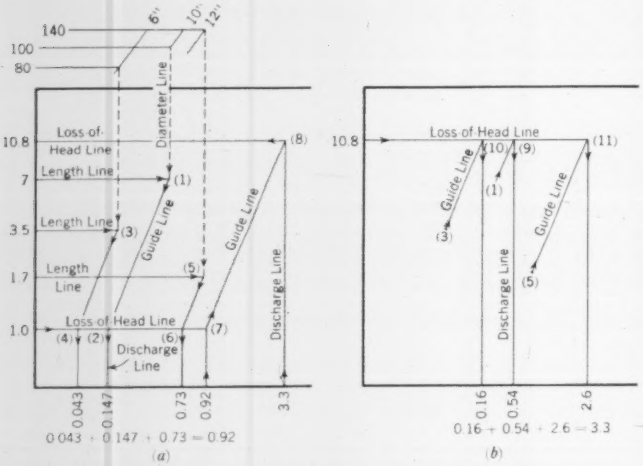

FIG. 2. ILLUSTRATING THE METHOD OF USING FIG. 1 FOR COMPUTING THE FLOW THROUGH THREE PARALLEL PIPES

For convenience, two horizontal dotted lines have been placed on the diagram, one marked "100 gpm," and the other, "cu ft per sec." These lines facilitate the conversion of quantities of flow from one unit to another. For example, the guide line originating in the scale at the bottom at 1 mgd crosses the dotted line marked "cu ft per sec" on a discharge line indicated on the scale by 1.55. The same guide line intersects the dotted line marked "100 gpm" on a discharge line indicated on the scale by 7. That is, 1 mgd = 1.55 cu ft per sec = 700 gal per min.

I wish to express my appreciation of valuable suggestions made by John H. Gregory, M. Am. Soc. C.E., in the preparation of this article and in the method of presentation.

Critical Depth in Trapezoidal Channels

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IN order to determine critical depth in channels of trapezoidal cross section it has been necessary to solve the following formula by successive trial solutions (King, *Handbook of Hydraulics*, 2d edition, page 334):

$$D_c^3 = \frac{b + 2zD_c}{(b + zD_c)^3}\frac{Q^2}{g}$$

In this formula D_c is the depth of critical flow in feet; b, the bottom width of trapezoidal channel in feet; z, the ratio of horizontal to vertical side slopes; Q, the flow in cu ft per sec; and g, 32.16 ft per sec².

To eliminate the necessity of a trial solution, which at the best is a tiresome process, this equation may be rewritten in the form

$$g\left(\frac{D_c}{b}\right)^3 \frac{\left(1 + z\dfrac{D_c}{b}\right)^3}{\left(1 + 2z\dfrac{D_c}{b}\right)} = \frac{Q^2}{b^5}$$

or $M = Q^2/b^5$, in which M is a function of the side slope and the ratio of critical depth to bottom width.

Table I gives values of M for various values of side slopes and values of D_c/b within the range most frequently encountered in practice. To determine the value of D_c it is then necessary only to calculate the value of Q^2/b^5, enter the table under the given value of the side slope, read the corresponding value of D_c/b, and multiply by b.

TABLE I. VALUES OF M IN THE FORMULA, $M = Q^2/b^5$, FOR FINDING CRITICAL DEPTHS IN TRAPEZOIDAL CHANNELS

$\frac{D_c}{b}$	SIDE SLOPES OF CHANNEL, RATIO OF HORIZONTAL TO VERTICAL							
	1/4:1	1/2:1	3/4:1	1:1	1 1/2:1	2:1	2 1/2:1	3:1
0.10	0.0330	0.0339	0.0348	0.0357	0.0377	0.0397	0.0419	0.0442
0.11	0.0440	0.0453	0.0466	0.0480	0.0509	0.0540	0.0572	0.0607
0.12	0.0573	0.0591	0.0610	0.0630	0.0672	0.0716	0.0763	0.0813
0.13	0.0731	0.0756	0.0782	0.0810	0.0868	0.0930	0.0997	0.1067
0.14	0.0914	0.0948	0.0983	0.1021	0.1100	0.1186	0.1277	0.1372
0.15	0.1127	0.1172	0.1220	0.1269	0.1376	0.1490	0.1612	0.1741
0.16	0.137	0.143	0.149	0.156	0.170	0.185	0.201	0.218
0.17	0.165	0.172	0.180	0.189	0.207	0.226	0.247	0.269
0.18	0.196	0.206	0.216	0.227	0.250	0.274	0.301	0.329
0.19	0.232	0.243	0.256	0.269	0.298	0.329	0.363	0.399
0.20	0.271	0.285	0.301	0.318	0.353	0.392	0.434	0.479
0.21	0.314	0.332	0.351	0.372	0.415	0.463	0.515	0.571
0.22	0.362	0.384	0.407	0.432	0.485	0.544	0.607	0.675
0.23	0.415	0.441	0.469	0.499	0.563	0.634	0.711	0.794
0.24	0.473	0.504	0.537	0.573	0.650	0.735	0.828	0.927
0.25	0.536	0.572	0.613	0.654	0.746	0.848	0.958	1.077
0.26	0.604	0.647	0.694	0.744	0.853	0.973	1.10	1.25
0.27	0.678	0.729	0.783	0.842	0.970	1.112	1.27	1.43
0.28	0.759	0.817	0.881	0.949	1.099	1.264	1.45	1.64
0.29	0.845	0.913	0.986	1.066	1.240	1.432	1.64	1.87
0.30	0.938	1.016	1.101	1.192	1.392	1.617	1.86	2.13
0.31	1.04	1.13	1.22	1.33	1.56	1.82	2.10	2.41
0.32	1.14	1.25	1.36	1.48	1.74	2.04	2.36	2.72
0.33	1.26	1.37	1.50	1.64	1.94	2.28	2.65	3.06
0.34	1.38	1.51	1.65	1.81	2.15	2.54	2.96	3.43
0.35	1.51	1.66	1.82	2.00	2.39	2.82	3.31	3.83
0.36	1.65	1.81	2.00	2.19	2.64	3.13	3.68	4.27
0.37	1.79	1.98	2.18	2.41	2.90	3.46	4.08	4.75
0.38	1.95	2.16	2.38	2.64	3.19	3.82	4.51	5.27
0.39	2.11	2.34	2.60	2.88	3.50	4.20	4.98	5.84
0.40	2.28	2.54	2.83	3.14	3.83	4.62	5.49	6.45
0.41	2.46	2.75	3.07	3.41	4.19	5.06	6.04	7.10
0.42	2.66	2.97	3.32	3.71	4.57	5.54	6.62	7.81
0.43	2.86	3.21	3.60	4.02	4.97	6.05	7.25	8.58
0.44	3.07	3.46	3.88	4.35	5.40	6.60	7.93	9.40
0.45	3.29	3.72	4.19	4.70	5.86	7.18	8.65	10.28
0.46	3.53	3.99	4.50	5.07	6.35	7.80	9.43	11.2
0.47	3.77	4.28	4.84	5.47	6.87	8.46	10.26	12.2
0.48	4.03	4.58	5.20	5.88	7.42	9.17	11.14	13.3
0.49	4.30	4.90	5.58	6.32	8.00	9.92	12.08	14.5
0.50	4.58	5.23	5.97	6.78	8.62	10.72	13.08	15.7
0.51	4.87	5.58	6.39	7.27	9.27	11.6	14.2	17.0
0.52	5.18	5.95	6.82	7.78	9.96	12.5	15.3	18.4
0.53	5.50	6.33	7.28	8.32	10.69	13.4	16.5	19.9
0.54	5.83	6.74	7.76	8.89	11.46	14.4	17.8	21.5
0.55	6.18	7.16	8.26	9.49	12.27	15.5	19.1	23.2
0.56	6.54	7.59	8.79	10.1	13.1	16.6	20.5	24.9
0.57	6.91	8.05	9.34	10.8	14.0	17.8	22.1	26.8
0.58	7.30	8.53	9.92	11.5	15.0	19.0	23.7	28.8
0.59	7.71	9.02	10.52	12.2	16.0	20.4	25.4	30.9
0.60	8.13	9.54	11.15	12.9	17.0	21.8	27.1	33.2

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Discussion of Membership Grades

Dear Sir: The recent vote on the constitutional amendments (page 715 of the November 1935 issue of Civil Engineering) designated as Proposal I, showed 1,582 against and 2,311 for the amendment, lacking 284 of the required two-thirds majority.

This is one of the heaviest votes polled in Society elections in recent years, yet the favorable vote was only 19½ per cent of the potential voting strength of the Society. It would seem that before any such far-reaching changes even be considered, a far more representative opinion of the Society at large should be obtained.

It was suggested to me by Prof. William J. Cox, M. Am. Soc. C.E., of Yale University, that a questionnaire be mailed to every voting member to ascertain previously whether there is a desire for any change at all in the present grade designations. I would heartily subscribe to such a plan.

The present grade names have evolved through the many years of the Society's existence and are not to be lightly changed for a mere pedantic whim. I fail to see any advantage either to the engineer or to the public even if all the several grades of the Founder Societies be designated by the same names. I do not believe that such is possible of consummation, but if it were, is there anything to be gained by it? Are we not following a will o' the wisp?

Those in any of the six grades of the Society's membership are "members" to the public at large, and only in engineering circles is a distinction recognized between member and Member. The Associate Member is in excellent company, for who does not recognize the dignity attached to Associate Professor, Associate Justice, etc.? Some much intermediate grade is quite necessary between Junior and Member, and this stepping stone to greater glories should not be removed.

If the membership should indicate that a higher grade than the present Member is desired, then the term Senior Member might be considered. But no matter what name it may be given no group should aspire to achieve it en masse. Transfer should be by careful scrutiny of individual professional records.

J. C. Stevens, M. Am. Soc. C.E.
Consulting Engineer

Portland, Ore.
January 7, 1936

Dear Sir: In line with the current discussion in regard to the change in the designation of membership grades, I would like to add, for what they may be worth, a few ideas that have come to my mind on the subject.

Webster defines the word "member" as "one of the persons composing a society, community, or party." In this strict sense of the word, therefore, the youngest Junior can be considered as much a member of the Society as the oldest Member. However, I believe that probably all of the members agree that there should be some distinctive grades of membership within the Society and that these grades should be indicated by appropriate titles. What, then, are to be considered appropriate titles? To my mind the titles should conform more or less to the following three requirements: (1) They should indicate without any ambiguity the fact of membership in the society; (2) they should indicate by their nature the grade of such membership; and (3) the title for each grade should be concise and in such a form that it will emphasize the fact of membership and subordinate the question of the grade of such membership.

None of the present titles for the three main grades of membership—namely, Member, Associate Member, and Junior—can be said to fully meet all of the above requirements. The suggested title of Fellow, while it may have its merits, to me, at least, seems too high sounding and probably too European to be applied to a grade of membership in an organization which by its very nature is predominately American; furthermore, it does not satisfy the above three requirements. That the term Associate Member is ambiguous can be noted by again referring to Webster who gives as one of the definitions for the word "associate" the following: "admitted to some, but not all rights and privileges; as, an associate member." So far as I know, an Associate Member of the Society lacks none of the many rights and privileges of any other member except the very proper lack of the privilege of using the unqualified title of Member.

In line with the above reasoning, I suggest that the titles of Member, Associate Member, and Junior be replaced with those of Member (Grade A), Member (Grade B), and Member (Grade C), respectively. As an alternative suggestion, although probably not in strict agreement with all the preceding thoughts, the titles might be Member, without the qualifying suffix as at present, Member (Grade B), and Member (Grade C).

A further alternative is brought to mind by drawing a parallel with the designation of relative rank in the U. S. Navy. In the navy there are two commissioned grades of lieutenant, namely, the grade of "Lieutenant" with no qualifying suffix, and the grade of "Lieutenant (Junior Grade)," commonly written "Lieutenant (J.G.)." This suggests the following designations for the three grades of membership: Member, Member (I.G.), and Member (J.G.), the expressions "I.G." and "J.G." standing for intermediate grade and junior grade, respectively.

Personally I like this last suggestion best of all. No doubt, however, the objection will be raised that the expressions "I.G." and "J.G." following the word Member will not mean much to the general public. However, is this an important objection? Is not the principal function of the title to convey the idea that the individual is connected with the organization? His relative grade within the organization, while it may be of importance to his fellow members, is of small importance to the public at large.

This discussion should not be construed in any way as a direct criticism of the present designation of grades; however, if changes in these designations are to be contemplated, the above ideas are offered as suggestions. Some may consider these suggestions rather radical; however, I will be glad to learn of the reaction of the membership to them.

William H. Overshiner, Assoc. M. Am. Soc. C.E.
Assistant Engineer, Orange County Flood Control District

Santa Ana, Calif.
December 27, 1935

Use of Large-Scale Photographs in Property Surveys

To the Editor: In his article on "Surveying and Mapping in the Tennessee Valley," in the December issue, Ned H. Sayford, M. Am. Soc. C.E., states that the cost of land acquisition surveys, by the use of enlarged aerial photographs, is only about one-third of preliminary estimates for property surveys made by the usual methods. As a matter of fact, a fairly large part of Norris reservoir in northeastern Tennessee was surveyed at the beginning of the program by running a fourth-order traverse line along each property boundary, then plotting up these traverses on white sheets of paper, the areas being planimetered. The cost for such property surveys as were completed under this method was considerably more than three times the cost of the present photographic surveys.

The large-scale photographs used on the property surveys have proved to be useful in many ways not at first anticipated. Perhaps a brief explanation of a typical use will suffice for illustration. The photographs are used on occasion as the basis for recovering original government subdivision corners. In sectionized areas, for example, the first operation is to find as many as possible of the original section and quarter-section posts. While many of the existing marks are not the original posts set by the first surveyors, they are nevertheless so well established that it would be futile to question their locations. There are other places, however, where there is now no definite surface mark, or no line evidence as to its original location. The procedure, then, is first to try to find the original corner, and if this is not recoverable, to set a new corner as nearly in the original location as possible. The regulations of the General Land Office, of the Department of the Interior, give certain rules for reestablishing the locations of lost or obliterated section corners. These regulations require that the nearest existing section or quarter-section corners be found, that distances between these existing markers be measured, and that the corners be relocated by the principles of double or single proportion.

It is evident that, within the scale accuracy of the photograph, scaled measurements may be substituted for measurements taped on the ground, provided the nearest existing corners are properly plotted on the photographs. By following the instructions of the General Land Office to the letter, except for substituting these scaled measurements for ground measurements, many corners have been positioned by proportioning—but plotted on the photographs instead of staked on the ground. The next step is to visit the ground at the location indicated by the photograph, and to search and dig for the original corner mark. In a surprisingly large number of cases the original post has been recovered within a short distance of the location indicated on the photograph. What is even more remarkable, in a few instances such original corners have been discovered in places where an erroneously restored corner has been accepted without question for years.

GEORGE D. WHITMORE, Assoc. M. Am. Soc. C.E.
Chief, Surveys Section, Engineering Service Division, Tennessee Valley Authority

Knoxville, Tenn.
January 3, 1936

Odor Control in Sewage Plant

TO THE EDITOR: I should like to make a few comments in connection with the article on "Odor-Control Experiments at Pasadena" by O. H. Hedrich, in the September issue. Pasadena has been a pioneer in its methods of sewage treatment, having been the first large city in the West to adopt the activated sludge process, the mechanical system of sludge drying, and scientific methods of odor control. The results, which have been achieved during 12 years of constant experimentation, indicate a measure of cooperative support on the part of the city government toward the plans and recommendations of its engineering department that is rarely found in engineering practice.

Odor complaints are not all confined to mechanical sludge dryers, such as the one at the Pasadena tri-city plant. Five years ago the Whittier Imhoff tank-sprinkling filter plant was being operated under very negligent management, and conditions that rendered the plant objectionable to the inhabitants of the surrounding territory had been allowed to develop. Early in 1931 a survey of odor conditions about the plant was ordered. The investigation finally disclosed the following sources of odor: (1) The screen house; (2) the Imhoff tank and dosing chamber; (3) pools of sewage and piles of scum on the plant site; (4) sprinkling filters; (5) the creek below the plant; and (6) fields irrigated with settled sewage taken from the plant ahead of the sprinkling filters.

Our conclusions were formulated in a report, filed with the city council, in which the following recommendations were made: (1) That the Dorr screens be operated continuously, but that the size of the slots be increased to at least $^1/_2$ by 2 in. in order to reduce the volume of screenings as well as the volume of putrescible matter in the screenings; (2) that an oil-fired incinerator be installed in the screen house so that screenings need not be taken outside the house; (3) that a tank for pre-aeration and for oil skimming be constructed; (4) that provision be made for treating the effluent with liquid chlorine; (5) that the plant grounds be leveled off and drained where necessary and that the debris from past construction work be removed; and (6) that more attention be paid to cleanliness around the plant than had been the rule.

These recommendations were carried out at an expense of $14,388, and the work was completed in March 1932. One of the changes made in the Dorr screen installation that caused a very pronounced reduction in odors in the screen house, was the substitution of an air-lift pumping device for the chain-bucket mechanism which was being used to remove the sludge from the screen pit. This device effectively removes both scum and screenings from the sump without allowing odors to form.

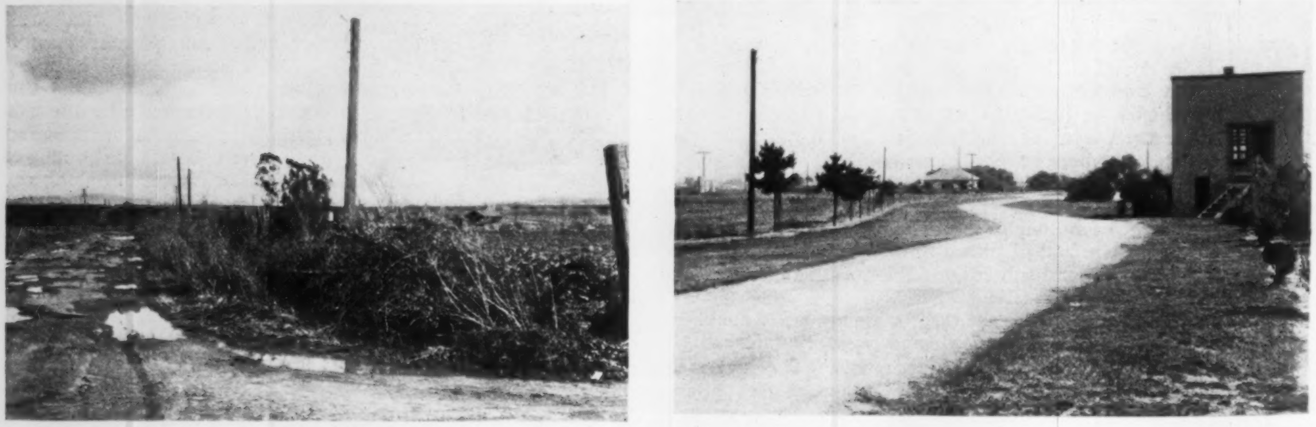
The aerator, which was installed expressly for odor reduction, was placed between the screen house and the Imhoff tank. It has a length of 40 ft, a width of 10 ft, a water depth of 8 ft, and a detention period of 26 min. Although the detention period is short, it is sufficient to restore the depleted supply of dissolved oxygen to a point where the production of hydrogen sulfide is effectively stopped. This increase in dissolved oxygen is accompanied by a corresponding decrease in the bio-chemical oxygen demand. Chemical determinations indicate a reduction in bio-chemical oxygen demand that is equal to 13.6 per cent of the original demand, and a hydrogen sulfide reduction from 1 ppm to merely a trace.

During the three years that these improvements have been in operation no complaints have been made to the city, although there is one house within 700 ft of the plant, 20 houses within 2,000 ft, and 40 houses within 3,000 ft. A marked improvement is shown in the condition of the final effluent, which is now being used for irrigation of cereal crops, as its use is not permitted on vegetables or other crops that are used for human consumption raw.

The Pasadena experiments have been so handled that a considerable part of the heavy cost involved has fallen on the manufacturers of special equipment.

ALVA J. SMITH, M. Am. Soc. C.E.
Manager, Los Angeles Office of Black and Veatch

Los Angeles, Calif.
December 30, 1935



ENTRANCE TO THE SITE OF THE WHITTIER IMHOFF PLANT
(Left) View Before Improvements Were Made. (Right) View After Improvements Were Made

Comments on Steam-Plant Design

To the Editor: Thomas T. Eyre's paper, in the September issue, is an interesting and valuable review of present practice in steam-power plant design in the United States. The engineers connected with the development of modern steam central-station power in Southern California, with its remarkable efficiencies and outstanding performance records, can be justly proud.

A steam plant has a lower investment per kilowatt than a hydro-electric plant and is better adapted economically to carrying low load-factor loads involving periodically idle equipment. In Fig. 1 is shown the trend of installed cost per kilowatt of generating capacity of Southern California central stations. It is interesting to note the low costs of the Pasadena municipal power plant.

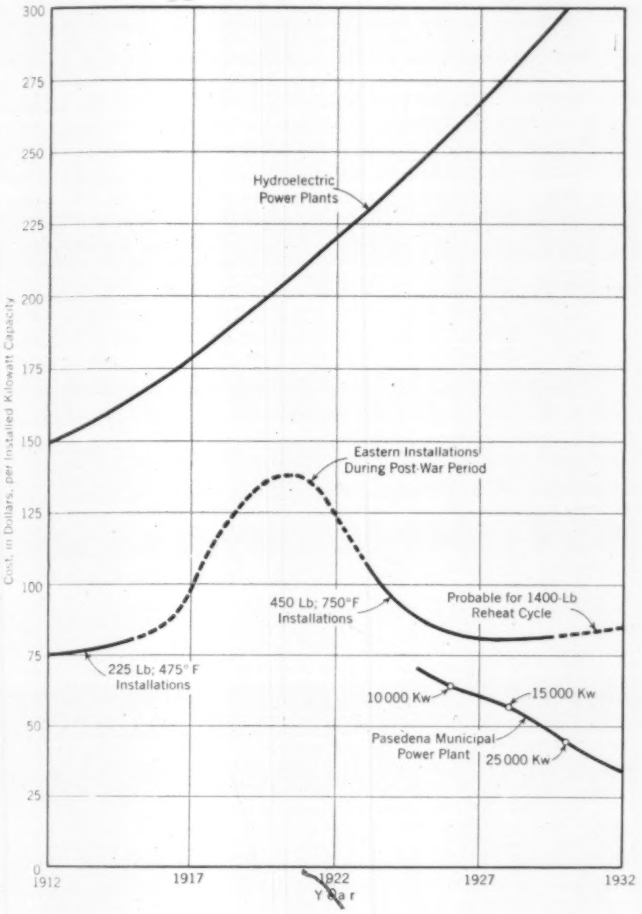


Fig. 1. Trend of Installed Cost per Kilowatt of Generating Capacity of Southern California Central Stations

The efficiency of several present-day steam cycles is indicated in Table I. While these efficiencies seem remarkable compared with past performances in the last decade, they are quite low when compared with possible future efficiencies. For the best of the previously-mentioned cycles only 37 per cent of the total heat in the fuel is made available in power at the bus bar.

The remarkable improvement in steam plant performance with very cheap fuel has caused a complete change in the economic balance of hydro-electric and steam energy. From the early development of hydro-electric power plants with 100 miles or more of transmission line, to the present large hydro-electric plants, the proportion of stand-by steam installation to the total hydro-electric installation of the system has changed from 25 per cent steam installation and 75 per cent hydro-electric installation at peak load, to from 80 to 90 per cent steam installation and from 10 to 20 per cent on hydro-electric installation. Because of economic necessity future power demands will be absorbed by steam plants.

Due to the advance in metallurgical accomplishments and the art of welding, and to improvements in forced draft and circulation, a revolutionary change in the design of boilers, in which the heating surfaces will be reduced to less than 3 sq ft per boiler hp, can be anticipated.

It is interesting to note that as steam pressure becomes greater the increase in efficiency is less rapid. The economic advantage of higher pressures is an intricate problem. The prime mover of today or tomorrow must be built to suit our new conditions of high pressures and speeds consistent with economy and reliability. Engine designs considered revolutionary or impractical in the past are actually on the market today.

Table I. Efficiency of Modern Steam Cycles

Steam	Kw-hr per Barrel of Fuel Oil (6,250,000 Btu)	Relative Plant Efficiency in Per Cent
At 450 lb pressure, 775 F temperature	490	72.6
At 1,400 lb pressure, 800 F temperature (Reheating to 775 F at 450 lb pressure)	550	81.5
At 450 lb pressure, 1,000 F temperature	580	86.0
Mercury vapor-steam process	675	100.0

Reciprocating steam engines of various types have rotary speeds as high as 1,200 rpm, which render efficient performance as shown from the records made by such engines as the piston high speed "capsule" engine or the uni-flow multi-cylinder machines. Due to their flexibility, these types of steam engine are suitable for wide load variations and can be directly connected to machines, such as blowers and pumps. The higher rotary speeds were pioneered by the internal combustion engineers; the high-speed reciprocating engine is simply a continuation of these designs. High speeds make it possible to reduce the weight of machinery per unit of power and thus obtain increased capacity at less cost.

The possibility of reducing vibration in engines has stimulated intensive thought during the last decade, and vibration control is now one of the major factors in machine design.

Vibration phenomena of practical importance are the vibrations transmitted to foundations by machines, and the torsional oscillations of shafts. Modern research has made it possible theoretically to control the vibration of engines within the limits of operation. Such problems as critical speeds, balancing of masses, flutter and internal hysteresis of shafts, and damping can often be solved within practical limits.

Supplementing the theoretical analysis, close checks can be obtained by the use of automatic dynamic balancing machines in the manufacturing process. Ingenious methods of determining the vibrational characteristics of engines in actual operation have been devised.

R. M. Beanfield, M. Am. Soc. C.E.
Consulting Engineer

Los Angeles, Calif.
January 6, 1936

Indeterminate Equations Were Studied by the Ancient Greeks

To the Editor: In an article entitled "Problems Requiring Integral Values of Variables," which appeared in the November issue, George J. Viertel, Jun. Am. Soc. C.E., called attention to one of a variety of problems in algebra which are in the class of indeterminate or Diophantine equations. Although Diophantine equations may have relatively few practical applications, they occupy a significant place in mathematical history and offer possibilities to one who is interested in the more advanced recreational aspects of mathematics.

There is little documentary evidence to fix definitely the period in which Diophantos of Alexandria made what are conceded to be among the earliest contributions to algebraic analysis. In a study of Greek algebra by T. L. Heath entitled *Diophantos of Alexandria* (Cambridge University Press, 1885), the author placed Diophantos in the second half of the third century of our era. Accordingly he was a contemporary of Pappus, who is known for his work in the fields of geometry and mechanics. These two men, living in the period when Greek mathematics generally was on the decline, appear to have been little appreciated or understood by writers of their own times and their work is not generally known today.

Of Diophantos' mathematical writings, 6 books of arithmetic and a tract on polygonal numbers have survived. Some mathematical writers of the sixteenth and seventeenth centuries have referred to 13 books on arithmetic by Diophantos, although nothing seems definitely to be known about 7 of them.

It may be inferred from quotations from Hankel's *Zur Geschichte der Mathematik in Alterthum und Mittelalter* (Leipzig, 1874, pp. 164–165) that Diophantos' methods appear to have resembled more the methods of an engineer than those of a mathematician.

Some 130 indeterminate problems have been divided into more than 50 classes in no generally systematic order. According to Heath (*loc. cit.*, pp. 83–84), the solutions of these problems, "almost more different in kind than the questions," reflect the ingenuity of Diophantos in adroitly attacking indeterminate equations. "It is . . . difficult for a more modern mathematician even after studying 100 Diophantine solutions to solve the 101st question. . . . If we . . . read Diophantos' own solution we shall be astonished to see how suddenly [he] leaves the broad highroad, dashes into a side-path, and with a quiet turn reaches the goal." Not unlike the modern engineering analyst, he appeared to be satisfied with proving his solution for a given set of conditions without discussing considerations necessary and sufficient for broad generality.

Mr. Viertel has presented one example of an indeterminate equation of first degree with integral values of the variables. A second-degree equation of the same kind solved by Diophantos may be stated as follows: Find three integers, x, y, z, so related that the square of one is equal to the sum of the squares of the other two. In other words, if x, y, and z are the sides of a right triangle, what must be their values if all are to be integers? Diophantos' solution is as follows: $z = (m^2 + n^2)$; $y = (m^2 - n^2)$; and $x = 2mn$, in which m and n are any two positive integers $(m > n)$.

Reference is made to Hall and Knight's *Higher Algebra* (Macmillan Company, 4th ed., 1932, pp. 110–113) for a brief discussion of the solution of indeterminate equations.

F. T. MAVIS, Assoc. M. Am. Soc. C.E.
Associate Director in Charge of Laboratory
Iowa Institute of Hydraulic Research

Iowa City, Iowa
December 15, 1935

Can Political Economy Be Established as a Science?

DEAR SIR: In his article in the December issue of CIVIL ENGINEERING Gustavus W. Dyer took occasion to denounce the national administration by implying that its policies rested on a species of economic quackery. Without disputing the truth of this implication, I wish to call attention to the fact that in view of the unsettled state of political economy as a science such a conclusion is a matter of personal opinion.

For years the nation has been crying for a solution to the social problem of poverty amidst plenty. Professional economists, resorting largely to metaphysics, have accomplished little in the way of a solution. In specialized problems of the business world they have contributed much that is useful to business. They have not, however, in the broader field of political economy established even a semblance of science. No accepted principles are recognized as in physics or chemistry. No agreement even on the basic classifications of production and distribution factors has been reached. In fact, most professional economists believe that the establishment of accepted principles as in chemistry and physics is impossible. Is it any wonder that the doctors disagree?

Until it can be assumed by general acceptance that elementary laws have been discovered, talk of American principles and functions of government is idle nonsense. A government honestly striving to promote the general welfare has, therefore, no recourse but to experimentation. Since this course is fraught with grave dangers, it is my sincere hope that not only professional economists but engineers and all patriotic citizens will help to establish a foundation for political economy on natural law.

WALTER F. SWANTON, Jun. Am. Soc. C.E.
Junior Engineer, U. S. Bureau of Reclamation

Denver, Colo.
Jan. 1, 1936

The Development of California

TO THE EDITOR: To the interesting treatment of the subject, "Engineering Contributions to California," presented by J. B. Lippincott, M. Am. Soc. C.E., in the September issue, I venture the following additions.

Water Supply. The first engineering contributions to California were the twenty-one missions, with their extensive water supply systems, established between 1769 and 1823 by the Spanish Franciscan monks.

Although the water supply of the state is ample for all future needs, it is very unequally distributed geographically. The first study of the problem, made in 1873 by a board of army engineers, proposed the transfer of surplus water from the Sacramento Valley to the San Joaquin, and directed attention to the duty of both the state and federal governments to lay out "a comprehensive system of irrigation." Succeeding investigations and reports culminated in the so-called "State Water Plan" of 1930, which outlined a comprehensive plan for development.

Mr. Lippincott omitted mention of the Los Angeles aqueduct extension into the Mono basin. This project, now under construction, includes an $11^1/_2$-mile tunnel under the Mono Craters, a 150-ft rock-fill dam at Long Valley, and a 90-ft earth dam at Grant Lake. The San Francisco aqueduct, while neither the longest nor the largest in existence, involved extremely difficult construction problems. Faulted and shifting rock formations, with considerable quicksand, made construction progress on the tunnels exceptionally difficult, and inflammable ground gases necessitated the use of special methods and explosives. In the construction of the aqueduct of the East Bay Municipal Utilities District, great credit is due the late Arthur P. Davis, Past-President Am. Soc. C.E., and chief engineer, for the speed attained, notwithstanding many legal obstacles.

Railroads. In 1862 the City and County of Los Angeles completed a railroad from Los Angeles to the harbor, 20 miles away. This publicly owned railroad was successfully operated until 1872, when the Southern Pacific Railroad, building southward from San Francisco, demanded and received as a price for construction through Los Angeles, rather than directly eastward, the payment of $377,000 in bonds, and the entire stock of the Los Angeles–San Pedro Line.

River Control. Since early hydraulic mining in this state failed to impound the debris, it greatly injured river navigation and increased the flood menace. Hence the California Debris Commission, consisting of a board of army engineers, was created to control hydraulic mining, restore navigability, and plan flood control. This Commission first prohibited further hydraulic mining without permanent impounding of debris. Now it is constructing four large concrete debris-restraining dams for use by miners at proper compensation.

The Sacramento River flood-control project recently completed by this Commission, and financed jointly by the state and federal governments, retains within the river channel between the levees only a certain maximum flow. It discharges the excess over spillways into leveed by-pass channels across the adjacent basins, to reenter the main river channel at a lower point, from which the river channel has been widened and deepened to its mouth.

A most interesting chapter in the development of the state deals with the taming of the mighty Colorado River, the reclamation of the great Imperial Valley, the catastrophe of 1905 when the entire river flowed into the Imperial Valley, and the heroic task of returning this river to its original channel in the winter of 1906 and 1907. Of course the culminating Colorado River project, and that which will benefit California most, is the construction of Boulder Dam.

It should be recorded that the first survey of the Boulder Dam and reservoir site was made by the late Homer Hamlin, M. Am. Soc. C.E. At the risk of being considered foolhardy, he recommended a dam 700 ft high and a reservoir with an approximate capacity of 25,000,000 acre-ft., these dimensions being at that time totally unprecedented.

CHARLES T. LEEDS, M. Am. Soc. C.E.
Consulting Engineer

Los Angeles, Calif.
December 24, 1935

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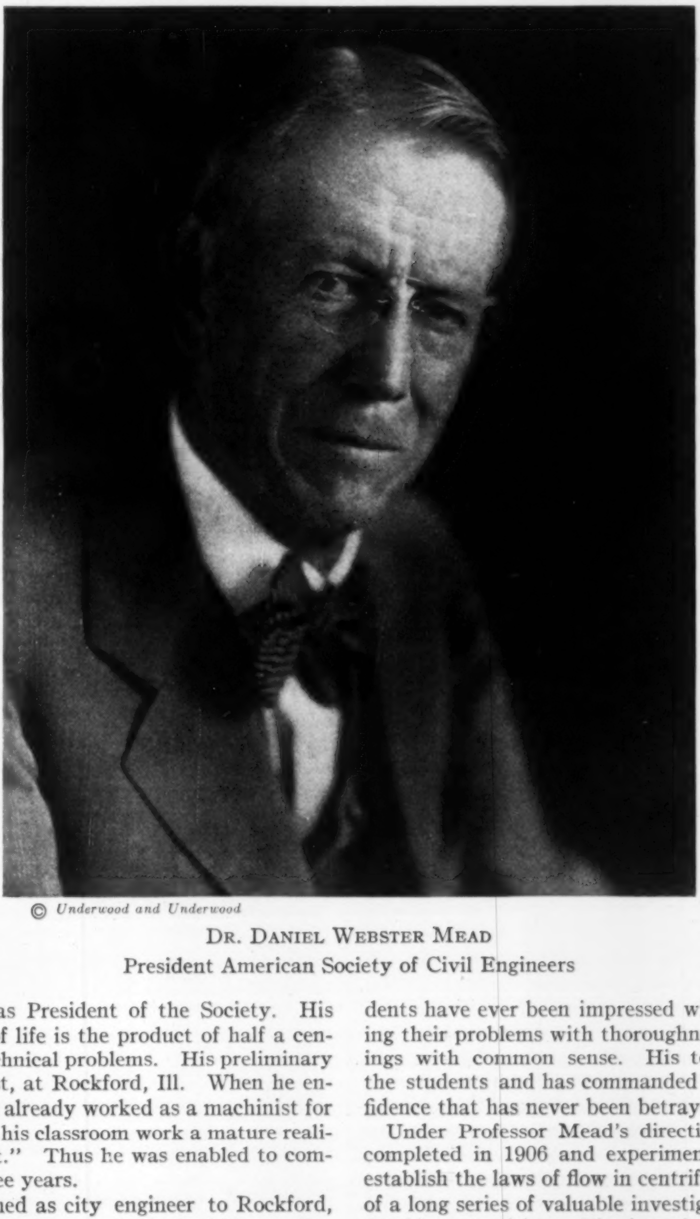
Official and Semi-Official

Daniel W. Mead, President for the Year 1936

Every engineer attending the Society Convention in Chicago the latter part of June 1933, will vividly recall one particular session, extending through the afternoon of a sweltering day. The question under discussion was the St. Lawrence River power project. The subject itself was a controversial one—engineers, public officials, and politicians held widely diverse opinions. Perhaps these were only contributing causes and it was the oppressive heat that added the last straw to the natural tension of the situation. Whatever the cause, questions of political expediency, personal and corporate interests, and technical deductions of varying import were offered with deep conviction. Throughout it all, the author of the paper, Daniel W. Mead, seemed to be the most unconcerned man in the audience. During the attack on his paper, and the equally strong defense, he was perfectly calm. At its close, he arose and in a few well-chosen words exploded most of the criticisms. The roar of applause as he sat down, from those who disagreed as well as from those who agreed with his views, was a genuine endorsement of him personally and a tribute to his engineering reputation.



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Dr. Daniel Webster Mead
President American Society of Civil Engineers

This spontaneous outburst was indeed significant of the firm place that Dr. Mead has earned for himself in the hearts of all civil engineers, which esteem is now brought to its logical conclusion by his election on January 15, 1936, as President of the Society. His philosophy of engineering and of life is the product of half a century of intimate contact with technical problems. His preliminary training was in the Middle West, at Rockford, Ill. When he entered Cornell University, he had already worked as a machinist for some time, and so he brought to his classroom work a mature realization of "what it was all about." Thus he was enabled to complete his four-year course in three years.

For his employment he returned as city engineer to Rockford, where a troublesome problem in water supply awaited him. One of the engineers who worked under him at that time says, "I can testify as to the thorough foundation which he laid for the work of that department. Every design was a new problem, and he brought to bear upon its solution all available scientific and experimental information, to which were added the results of his own and others' experiences gleaned from all sources."

His solution of the water supply problem at Rockford was ingenious and successful and attracted the attention of engineers in that part of the country. He was soon recognized as a leader of his profession in the state. When the need for a state society of engineers was felt, he was among the group that established the Illinois Society of Engineers, and for many years he was one of the wheel horses of that organization. Even at this early date, one of his friends records that "He had a high regard for engineering as a profession, and believed that its progress could best be promoted by the liberal cooperative efforts of its members. In contrast to the prevailing practice of those days, he was extremely liberal in making available to other engineers the results of his own analyses and the details of his own practice."

A brief experience as a contractor on municipal improvements followed, but he was soon back in engineering practice as a consultant in the field of water supply. In this he was highly successful and established a reputation that attracted attention to him when the University of Wisconsin, in 1904, decided to develop a strong department of hydraulic and sanitary engineering. He was asked to head the department, but with characteristic modesty he expressed doubts as to his ability to meet the requirements of the position and insisted upon a one-year tryout. This was the beginning of a period of service of twenty-eight years with the university, from which he retired in 1932.

To his teaching, Professor Mead brought the ability to conduct a scientific study of a problem and the ability to make a practical application of the results. His students have ever been impressed with the necessity for investigating their problems with thoroughness and for applying their findings with common sense. His teaching has been respected by the students and has commanded their utmost confidence, a confidence that has never been betrayed.

Under Professor Mead's direction a hydraulic laboratory was completed in 1906 and experiments were begun immediately to establish the laws of flow in centrifugal pumps. This was the first of a long series of valuable investigations that were conducted under his supervision. The introduction of laboratory demonstrations into the teaching of theoretical hydraulics at the University of Wisconsin was, so far as is known, a new thing in engineering education in this country. He believed that "No subject can be so thoroughly well taught that it will become fully the mental property of the student until he has had the opportunity of putting it into active use in his practice in many places and at many times."

The subject of hydrology was introduced into engineering curricula by Professor Mead, who considered it an essential preliminary course that should precede any advanced work in hydraulic engineering. In 1919 he published *Hydrology*, the first textbook on the subject. This was the third of his texts; his *Water Power*

Engineering appeared in 1908, and *Contracts, Specifications and Engineering Relations* in 1916.

When he took up his teaching duties it was with the understanding that he would continue his private practice, and he has, throughout the entire time, maintained his downtown office in Madison under the firm name of Mead and Seastone. He is also a member of the New York firm of Mead and Scheidenhelm. His practice and reputation grew steadily to national proportions. He was a member of the engineering board sent to China in 1914 by the American Red Cross and the Chinese Republic to study the problem of flood control on the Huai River; he was consulting engineer for the Miami Conservancy District during the planning and construction of the flood protection works in 1915; he was a member of the committee that investigated the 1927 Mississippi floods for the National Chamber of Commerce; he was a member of the Colorado River Board appointed under joint resolution of Congress to pass upon the plans for the Boulder Canyon project; and he is now a member of the board that represents the federal government in connection with the construction being done by the Chicago Sanitary District.

At the time of his retirement in 1932, the University of Wisconsin recognized his long and honorable service by bestowing upon him the honorary degree of doctor of laws. The American Society of Civil Engineers also gave recognition to his attainments by making him an Honorary Member in 1931.

Any one who has the privilege of conversing with Professor Mead for any length of time will receive the decided impression that he is well versed in his subject. Throughout his life he has sought information from all sources or persons, but always reserving to himself the right to an independent opinion. His method of appraising the value of his judgment is to determine the reactions that he himself experiences from his previous conclusions. And if the idea was not originally his, he will be the first to accord the proper credit for originality. In his analysis of engineering and economic problems, Dr. Mead is characteristically thorough. He cannot be stampeded into expressing an insufficiently considered conclusion on an important project. That is, he is loath to express his view until he has made as complete an appraisal of a problem as time and circumstances permit. Then he brings to bear great richness of experience, breadth of view, and maturity of judgment.

Consistently Dr. Mead has refused to enter into professional engagements unless and until the prospective clients have been made fully aware of any and every fact or view on his part which might prove embarrassing to them. Not infrequently this has resulted in terminating a negotiation for the engagement of his services under circumstances such that a less punctilious but thoroughly respectable engineer might, at least during the preliminary discussions, have remained discreetly silent. It goes without saying that his friends as well as his clients are thoroughly appreciative of this frankness.

Few engineers have, for so long a time and so thoroughly, intertwined consulting engineering practice with engineering education. His relationship to his university teaching work was from his standpoint happily such that he was able to devote something like half of his time to outside work. In keeping with his rôle as an educator, Dr. Mead is interested in the young engineer, especially the student. In the midst of study of an important engineering problem, in office or field, especially the latter, he has been alert to gather material to interest as well as educate the student engineer.

Generally his manner indicates the kindliness which is always in his heart. However, he is uncompromising as regards matters of principle and intolerant of sham. In consequence, when speaking on any subject he is likely to give an impression of sternness, arising from his very serious mien. But such an impression is misleading; beneath the apparent sternness there still lies the kindest of hearts. Moreover his seriousness is not to be taken as evidencing a lack of humor. Frequently he will undertake to relieve the strain of an important conference by interjecting a humorous story with a real point.

In his personal contacts he is modest, self-effacing, and far from egoistic. He shows these characteristics because they are intrinsic with him, not merely because he can afford to evince them.

As his engineer friends tend to become too deeply engrossed in their profession, his advice is "Learn to play when you are young so that you may know how to play when you are old." This advice he has applied to himself; he has learned to play a little golf but is not an addict. But his principal hobby is photography, in which connection he has established a well-equipped photographic workshop in his home. Both he and his friends get much pleasure from the still and motion pictures which he produces. The younger generation in the Mead family is now grown and scattered but Professor and Mrs. Mead still maintain the home where their friends delight to visit them, where Professor Mead is an entertaining host and Mrs. Mead a warm-hearted and hospitable hostess.

So it is just fifty years since Dr. Mead began his professional career as City Engineer of Rockford, that he has been elected to the presidency of the Society. During this long interval, devoted to active practice and to teaching, he has been unusually successful in both fields. He comes to this high position recognized as an authority in the field of hydro-electric development, with a practice that has covered the nation. He also brings wide recognition as an eminent teacher in the field of hydraulics, in which his textbooks are extensively used throughout the country. Following the high standards set during his student days, both personally and professionally, he has maintained and enhanced his reputation for integrity during a long career as an engineer, as a teacher, and as a citizen, and has been an inspiration to his students and co-workers.

That he holds decided views and can give expression to them with absolute fearlessness is well known among American engineers. It was therefore a simple statement of fact and not a boast when he summed up his philosophy before the well-remembered Society meeting in Chicago with these significant words: "I have never had to take the collar from any party or any state or any corporation. I have been an independent thinker and have always been able to express and willing to express my candid opinion upon a public subject." It is in this vigorous personality, characterized by such an outstanding "declaration of independence" that the Society gladly reposes its utmost confidence as its President during 1936.

Features of the Eighty-Third Annual Meeting

IF ONE may judge by the increased registration and the spirit of buoyancy in evidence at the Annual Meeting, civil engineers at least are willing to consider that the worst of the depression is a thing of the past. The figures on registration, showing more than 2,000 in attendance, speak for themselves. The optimistic outlook was so generally felt that it was the subject of frequent comment.

An outstanding feature of the opening session on Wednesday morning, January 15, was the simple but impressive ceremony of conferring honorary membership and prize awards. Two of the new Honorary Members—John F. Coleman of New Orleans, La., and William J. Wilgus of Ascutney, Vt.—were present to receive their certificates. The remaining two—Mortimer E. Cooley of Detroit, Mich., and John W. Alvord of Chicago, Ill.—were prevented by illness from attending. Dean Cooley was represented by his son, Hollis M. Cooley, Captain, U. S. Navy, and Dr. Alvord by his partner, Charles B. Burdick.

Among the prize-winners, two had been removed by death since the papers were written. The late D. C. Henny was represented by his son, Arnold Lorentz Henny, and the late Robert H. Simpson by his wife. The rest were present for the ceremony.

Following the presentation of the awards, retiring President Arthur S. Tuttle introduced the incoming President, Daniel W. Mead, who responded with a brief address. The annual reports of the Board of Direction, the Secretary, and the Treasurer, and reports of various Society committees completed the business of the session.

On Wednesday afternoon the meeting arranged by the Engineering-Economics and Finance Division attracted a large attendance and evoked a spirited discussion that centered about principles for controlling governmental expenditures for public works.

The first day of the meeting concluded with a formal dinner and dance in the Grand Ballroom of the Hotel Roosevelt. A reception to the newly elected President and Honorary Members was a feature of the occasion.

Technical sessions began early on Thursday and occupied the entire day. The Construction Division heard and discussed papers on earth moving, concrete handling, welding, and structural erection practice. The program of the Highway Division included discussions of recent developments in pavement design and of the highway connections with the Triborough Bridge. City planners devoted their entire morning session to a consideration of the use and limitations of work relief in the advancement of building programs. The subject discussed at the afternoon session was the future of land subdivision and its problems. The Sanitary Engineering group also held two sessions, featuring papers on a wide variety of subjects, including the permeability of earth dam foundations, the design of aeration tanks, and the grinding of garbage and its disposal in sewers. The Structural Division received reports of four of its committees—those on Modern Stress Theories and Fatigue Research, Structural Alloys, Wind Bracing in Steel Buildings, and Bridge Floors.

© *McLaughlin Aerial Surveys*

THE TRIBOROUGH BRIDGE—OBJECTIVE OF INSPECTION TRIP AND SUBJECT OF TECHNICAL PAPER

Relaxation from the technical activities was provided on Thursday evening at a smoker and entertainment given at the Hotel Pennsylvania. Friday and Saturday brought the Eighty-Third Annual Meeting to a close with a series of inspection trips to local points of engineering interest.

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Governmental policies aroused lively discussion at several sessions. The report of the Committee on Principles to Control Governmental Expenditures for Public Works condemned the use of "yardsticks" for public utility plants, calling them "unnecessary, expensive, and unjustified," and suggesting that "all the information that such yardsticks could possibly yield might be had from study of the numerous publicly owned electric, gas, and water supply plants that now exist." A paper presented before the City Planning Division pointed out that while the National Resources Board has made good use of relief workers in preparing planning projects, and while state planning is continuing to make steady progress, the number of county and municipal planning projects so far set up under WPA is discouragingly small. It suggested that speed and efficiency have been materially sacrificed by centralizing all final decisions in Washington, and recommended that the federal offices should not attempt to review minor details.

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Dr. Mead concluded the address that followed his presentation at the opening session by saying: "Gentlemen, as your newly elected president, I shall have to ask your forbearance and assistance, not in any way to add to my own reputation, honor, or glory, but to assist this Society to acquire its rightful position and to secure unity, harmony, and service. Entering into this work almost as an outsider, although a member so long, I do not know what I may be able to do or whether I shall be able to do anything that will aid, but I will promise you this—that I shall do my very best for the ideals of unity, harmony, and service both for the Society, its membership, and for our people and their government."

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Elsewhere in his address, Dr. Mead recounted an amusing incident that befell him recently. It seems that he wears the old-type pin with the level and the date 1852. One of the younger members, after examining it closely, inquired, "Dr. Mead, are you a charter member?"

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A crowd that taxed the capacity of the Grand Ballroom of the Pennsylvania Hotel attended one of the most pretentious smokers in the Society's history. A record attendance of over 1,600 was claimed for this function. It was the first time the affair had been held outside the Society's building. Entertainment was furnished by an orchestra and a well-selected group of radio and vaudeville performers. The "American Society of What-Not Engineers" made its appearance for the first time in several years, and two members of that mythical organization provided a rapid-fire continuity for the program.

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The stars in their courses performed for the engineers at the Hayden Planetarium on Friday afternoon. A visit to this fascinating institution was part of an all-day inspection trip that included a tour behind the scenes at Rockefeller Center. The Society was one of the first groups permitted a detailed inspection of the vast array of air-conditioning and other service equipment of that development.

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Several trips were conducted to points of engineering interest on Saturday, January 18. The Triborough Bridge attracted an interested group. Another party visited the Midtown Hudson Tunnel, now in process of construction, and a third party was conducted through the East River power station.

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An active committee of ladies made sure that entertainment was not lacking for the visiting ladies. A fashion review and tea were staged on Thursday at the Hotel Roosevelt, and in the evening a bridge party was given at the Engineering Woman's Club. Through the courtesy of that organization, the facilities of the club were made available to the ladies during the entire meeting.

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Several of the technical sessions and conferences taxed the capacity of the available rooms. The Structural Division meeting comfortably filled one of the largest assembly halls in the building, and students attending the Regional Student Conference packed the room originally assigned them and were finally transferred to a larger hall.

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In presenting the report of the Committee on Salaries, E. P. Goodrich included a series of slides that summarized the data collected by the committee. Several slides showing facsimiles of actual letters received by the committee in response to a questionnaire sent to county authorities provided an amusing conclusion to his report. One county reported: "In reply to your query on salaries for engineers, beg to state that we pay the engineer at the court house $1,200 a year, and the firemen $900."

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When the *Monarch of Bermuda* sailed from New York on Saturday, January 18, it carried a large group of Society members and their friends, en route to the islands for a week's vacation. The Bermuda trip was an innovation at last year's Annual Meeting, and met with such enthusiastic response that it was decided to repeat it.

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Those attending the luncheon on Wednesday noon welcomed the departure from the buffet arrangements of former years. The meal was served at tables—a plan that proved quite satisfactory but that threatens to make it necessary to find a larger room for next year's affair if interest in it increases.

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Between sessions, members and their friends were kept busy attending luncheons and dinners of various college groups. In all, 16 colleges and universities and one civil engineering fraternity had arranged reunions.

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Raincoats, old clothes, and boots were suggested as the proper dress for persons taking the Saturday inspection trips to the Midtown Hudson Tunnel and Triborough Bridge. The warning proved timely, for the weather added its contribution to the ordinary confusion of construction activities. A steady downpour continued throughout the morning. At last reports, visitors from California and other favored localities were complaining vociferously but bearing up well.

Theodore Roosevelt and the Engineer

ON THIS MONTH'S Page of Special Interest are reproduced two of the mural paintings on the north wall of the main room in the Theodore Roosevelt Memorial built by the State of New York. The memorial, an imposing $3,800,000 edifice adjacent to the American Museum of Natural History in New York, N.Y., was dedicated on January 19, 1936, with an impressive ceremony broadcast over a national network.

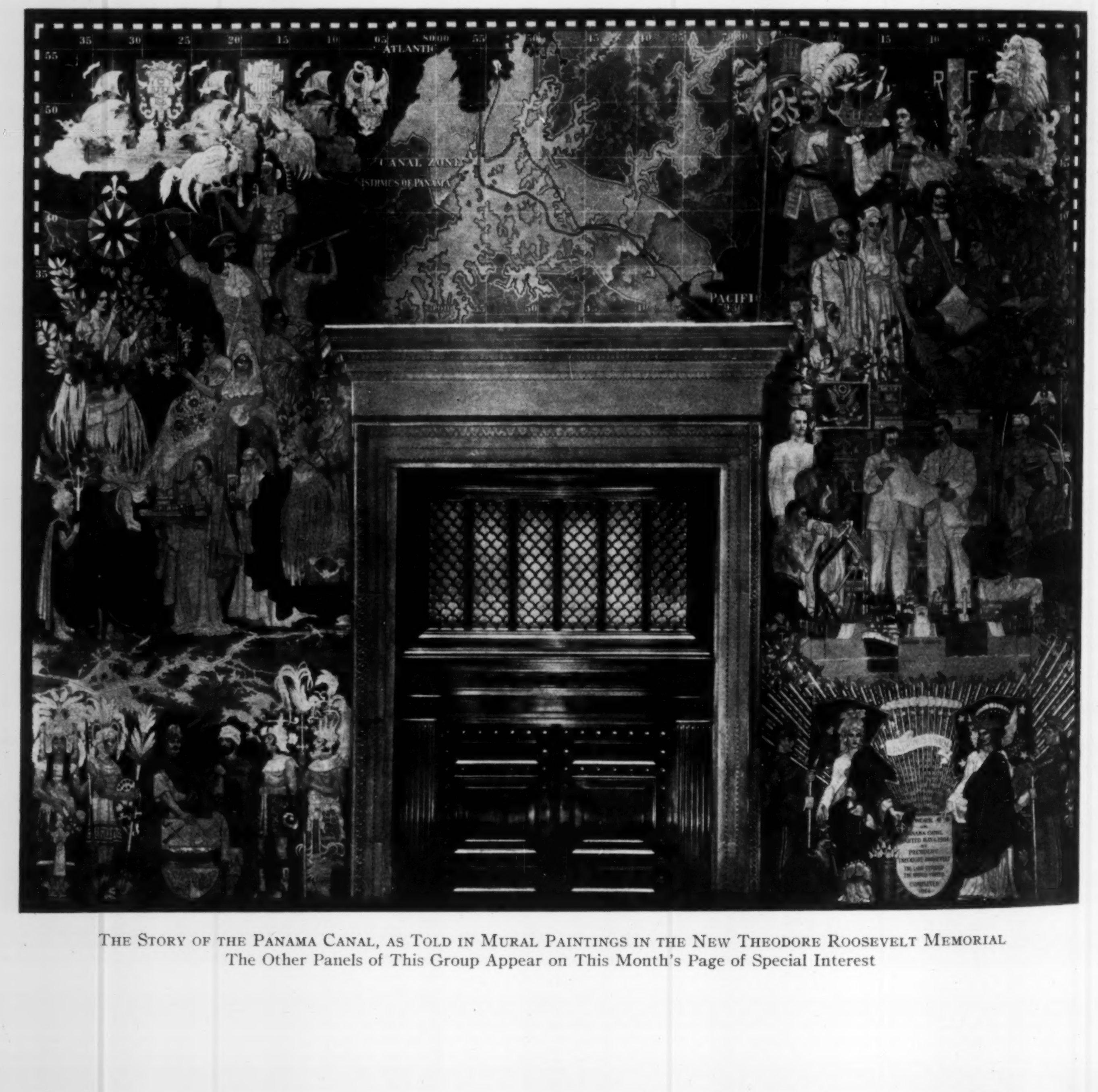
The mural on the left depicts the last act in the excavation of the Panama Canal—the meeting of two enormous excavating machines. Above, over the map of the Canal Zone, the steam from the shovels billows up in the form of the divided continents. Below appear figures of engineers and workmen, and a shield with the inscription, "The land divided, the world united." The companion piece on the right portrays a goddess pouring from a vessel, the "Unknown River" discovered and explored by Theodore Roosevelt and later named Rio Teodoro in his honor. The discoverer is shown viewing the river at its source, while his native attendants, with poles, push aside the rank jungle growth. Below, the President's son, Kermit, can be seen recording the story of the discovery.

The remaining murals of the Panama Canal group are reproduced on this page. The parts on each side of the door formed the Page of Special Interest in the April 1935 issue of CIVIL ENGINEERING and were described in detail in that issue. In the panel on the right, the engineer standing beside the President is John F. Stevens, Honorary Member and Past-President of the Society and chief engineer of the project.

On the occasion of his visit to the Canal Zone in 1906, Roosevelt paid a glowing tribute to the engineers engaged in the work. An autographed copy of his address to the employees of the Isthmian Canal Commission is now on display in Society Headquarters. "Next to man's home life," he said, "the thing best worth doing is something that counts not only for himself but for the country at large, and that is the kind of thing you are doing. I hope that the spirit already here will grow even greater such as will make each man identify himself with this work and do it in such shape that in the future it will only be necessary to say of any man, 'He was connected with the digging of the Panama Canal,' to confer the patent of nobility upon that man."

Theodore Roosevelt's interest in engineering and his realization of its importance were not confined, however, to his earnest endeavors in behalf of the Panama Canal; his persistent advocacy of a scientific national conservation policy is a matter of history. "The nation behaves well," he said, "if it treats the natural resources as assets which it must turn over to the next generation increased, and not impaired, in value." Again, "Conservation means development as much as it does protection." These quotations appear in bronze lettering in another part of the Memorial hall.

CIVIL ENGINEERING is indebted to William A. Mackay, the artist who painted these murals, for furnishing the photographs from which these reproductions were made.



THE STORY OF THE PANAMA CANAL, AS TOLD IN MURAL PAINTINGS IN THE NEW THEODORE ROOSEVELT MEMORIAL
The Other Panels of This Group Appear on This Month's Page of Special Interest

Epitome of Society Progress for Past Year

Extracts from the Annual Report of the Board of Direction for the Year Ending December 31, 1935

Unquestionably the most important event of the year just closed is the marked increase in reemployment of civil engineers. But few are now without employment although many are yet misplaced with respect to their particular qualifications. Salaries are better although still below those formerly paid. In organizations which have remained operative throughout the depression period those engineers who were retained are now receiving pay more nearly that of pre-depression days. Those engaged in the new or temporary organizations, particularly of the federal government, however, are receiving pay materially lower than that which they formerly received in their previous connections. Great numbers of civil engineers are directly or indirectly employed in connection with the enlarged public works programs sponsored by the federal government. To what extent this situation will continue is problematical. However, the call for civil engineers in relation to private industry has begun.

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Reemployment is reflected in Society statistics. More members have paid dues promptly. Applications for admission and reinstatement during the past year were 76 per cent of those of the maximum year, 1927, and 45 per cent greater than those of the minimum year, 1933. Thus it appears that the Society has been satisfactory to the membership and that the several special efforts made by its officers and other representatives toward reemployment have received recognition within the profession.

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Several new policies or procedures, effective in 1935, merit special mention. First, perhaps, is the continuation of the Committee on Aims and Activities and the acceptance of its report. One recommendation of the committee resulted in the addition to the staff of a Field Secretary. Through him and others of the staff, all but 3 Local Sections and 43 Student Chapters have been made more familiar during the past year with the Society's work. His primary function this first year, however, has been to study the problems of the Local Sections to determine if possible where and how they can be made more effective in behalf of the members of the Society and of the profession. On the other hand, he has afforded them assistance in regard to their approach to registration of engineers, preservation or rectification of local civil service conditions, and related salary problems.

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Another recommendation of the Aims and Activities Committee was that the Society take up aggressively, where appropriate so to do, the defense of members unjustly accused or dismissed without proper hearing. The method of procedure had no sooner been worked out than a case in point arose which was most thoroughly investigated and followed through to a fully satisfactory vindication of two members.

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The Aims and Activities Committee also recommended the resumption of Local Section conferences, the first of which was held at the time of the Birmingham Meeting.

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A fourth new procedure was the establishment of a nation-wide group of "employment correspondents." In order that prompt information of prospective positions of that character might be disseminated throughout the nation there was formed, through the medium of the Local Sections, this national group of members charged with understanding the conditions of local unemployment of civil engineers throughout the country and with readiness to respond to calls for any type of supervisory or technical service that might be needed. The most recent call has been for supervisory staffs of engineers to carry on local control surveys wherein the simpler operations are to be performed by the so-called "white collar" unemployed under the Works Progress Administration. This and other projects of varying nature, inquiries disclose, have resulted in at least the temporary reemployment of practically every civil engineer in the country.

* * * *

There are to be recorded again most gratifying facts in regard to membership in the Society. Total membership at the close of the year was 15,069. This is not the greatest number of members the Society has enjoyed but near to it. It has come about through recognition in the profession of the value of the Society to its members and the profession, coupled, of course, with renewed ability to pay the dues. One other circumstance permits the record of membership to stand, as it has stood throughout the recent trying years, at such a uniformly high figure. By action of the Board those loyal members who have long contributed to the support of the Society but who recently, by reason of unemployment or impaired income, have been unable to continue their financial support, have had certain of their dues remitted. In order to do this it was of course necessary to curtail certain former activities, to lower the salaries of the staff, to decrease somewhat the publications and research activities, and effect other economies. It is by these means that the Society as an organization has been maintained intact. The Board of Direction has adhered to the principle that the Society's real value is its "assets in men—not money." With the return of employment in this year, however, the necessity for these curtailments has decreased and many Society activities have been resumed and new ones undertaken. The necessity for remission of dues seems to be passing and shortly the Society should be able to widen and accelerate its programs and service more than ever before.

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The Society is in good financial condition. It does not owe debts of any kind. In the year just closed the budgeted expenditures exceeded anticipated income, but the increase in new members and the increased ability of former members to renew the payment of their dues made it possible to turn into a small surplus the anticipated deficit.

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The total number of membership applications was 1,361, of which 1,034 were for admission, including 12 for re-admission, and 222 for transfer.

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The Employment Service has offices in New York, N.Y., Chicago, Ill., and San Francisco, Calif. The number of men placed during 1935 has averaged about 100 per month.

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The losses by death during the year number 164.

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The publications of the Society for 1935 include 1 volume of Transactions (Vol. 100), 10 numbers of Proceedings, 12 numbers of Civil Engineering, a Year Book, 1 Manual, and 2 Separates ("Recommendations for Determining Fees to Be Allowed for Professional Engineering Services" and "Mapping for National Planning").

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The attendance at the Reading Room during the year was 2,076. Two hundred and fifty-seven periodicals are regularly received. Included in this number are many foreign periodicals, also a number of literary magazines and several daily newspapers.

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Five meetings of 7 sessions were held during the year, as follows: At the Annual Meeting, at New York, N.Y., 1 (1 session); at the

Annual Convention at Los Angeles, Calif., 2 (2 sessions); at the Fall Meeting at Birmingham, Ala., 2 (2 sessions); and 2 regular meetings held in Engineering Societies Building, New York, N.Y.

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All but one of the Technical Divisions of the Society held sessions during the year. Of these meetings seven were double sessions of which two were held jointly with similar divisions of this and other societies, at the Annual Meeting. The total membership in the Technical Divisions is 15,392.

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There are at present 112 Student Chapters. The following were organized during 1935: Utah State Agricultural College, Dartmouth College, and Brown University.

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During the year the disbursements by the Society totaled approximately $401,000. Receipts in the form of dues and entrance fees totaled $237,000; from advertising, $30,500; and from the rental of the 57th Street property, $52,500. Other income was from the sale of publications, entrance fees, etc.

(*The complete annual report of the Board of Direction for 1935 will appear in the February 1936 issue of* PROCEEDINGS.)

Final Ballot on Society Officers for 1936

33 West 39th Street
New York, N.Y.
January 8, 1936

To the Eighty-Third Annual Meeting
American Society of Civil Engineers:

The tellers appointed to canvass the ballot for officers of the Society for 1936 report as follows:

Total number of ballots received		3,192
Deduct:		
Ballots from members in arrears of dues	29	
Ballots not signed	57	
Ballots with illegible signature	1	
Total withheld from canvass		87
Ballots canvassed		3,105

For President	
Daniel Webster Mead	3,098
Scattering	3
Blank	4
For Vice-Presidents	
Zone I:	
Edward Payson Lupfer	3,071
Scattering	1
Blank	33
Zone IV:	
Harry Whiting Dennis	3,072
Scattering	5
Blank	28

For Directors		
District 1 (two to be elected):		
Carlton Springer Proctor	3,061	
James Kip Finch	3,035	
Scattering	7	
Blank	107	
Total votes registered	6,210	
Total ballots canvassed		3,105

District 4:	
Clarence Eugene Myers	3,066
Scattering	7
Blank	32
District 11:	
Raymond Alva Hill	3,058
Scattering	17
Blank	30
District 14:	
Leroy Lemayne Hidinger	3,074
Scattering	1
Blank	30
District 15:	
Edwin Percival Arneson	3,072
Scattering	2
Blank	31

Respectfully submitted,
SHORTRIDGE HARDESTY, *Chairman*

Louis E. Robbe
N. S. Covert
James Wilmot
Theodore Barbato
A. M. Anderson
G. M. Rapp
A. E. Clark
John J. Cope
James A. Darling
Clarence W. Dunham
James McB. Webster
Tellers

New Bulletin on Standards for Hydrologic Data

AGREEMENT on common standards and specifications for hydrologic data arrived at among representatives of different government agencies and prominent hydrologists outside of government service, is shown in a 45-page report of recommendations on the subject made public in November 1935, by the National Resources Committee. The report was prepared by a special advisory committee to the Water Resources Committee of the National Resources organization.

"The immediate urge and dominant thought governing the preparation of this report," the publication states, "have been the provision of dependable hydrologic data by means of work relief projects. The committee has departed somewhat from the strict letter of its instructions, and has ventured to recommend certain procedures affecting the collection and publication of basic data by the regular government agencies."

The committee's recommendations relate chiefly to the minimum standards regarded as compatible with the reliability and accuracy necessary for safe and economic design, and range from specifications for personnel and terminology, through standards for collection and compilation of data on precipitation, snow surveys, surface waters, ground water, evaporation, quality of water, and suggestions with respect to special projects, to recommendations for procedure for surveys under the Works Progress Administration.

Seven of the nine members of the special committee, as well as its two special consultants, are members of the Society. They are Thorndike Saville, chairman, professor of hydraulic and sanitary engineering, and associate dean, New York University; Donald M. Baker, consulting civil engineer, Los Angeles; H. K. Barrows, professor of civil engineering, Massachusetts Institute of Technology; N. C. Grover, chief hydraulic engineer, U. S. Geological Survey, Washington, D.C.; W. W. Horner, consulting civil engineer, St. Louis; Joseph Jacobs, consulting civil engineer, Seattle; and Royce J. Tipton, consulting enginer, Denver. The other two members of the special committee are J. P. Dean, Captain, Corps of Engineers, U. S. Army, New Orleans; and Willis R. Gregg, Chief, U. S. Weather Bureau, Washington, D.C. The two special consultants, also Members of the Society, are Robert E. Horton, of Voorheesville, N.Y., and Adolph Meyer of Minneapolis, consulting hydrologists.

Robert Fletcher Dies—Engineer and Educator

Robert Fletcher, M. Am. Soc. C.E. and director emeritus of the Thayer School of Civil Engineering at Dartmouth College, died in Hanover, N.H., on January 7, 1936, at the age of 88. Dr. Fletcher held the distinction of having been associated with the Society longer than any other living member, since he became an Affiliate in 1874. He was also one of the oldest graduates of West Point, being of the class of 1868.

The Late Robert Fletcher, M. Am. Soc. C.E.

Dr. Fletcher's most important work was probably in connection with the Thayer School, to which he was called as director (dean) on its organization in 1871, and of which he remained in active charge for almost a half century. On his retirement in 1918 he was made director emeritus and emeritus professor of civil engineering.

The Thayer School was one of the first to provide training in civil engineering as a sequel to a broad college course in the liberal arts, and under Dr. Fletcher's guidance many of the so-called modern trends in technical education were developed there. His progressiveness in educational methods won for him in 1901 the presidency of the Society for the Promotion of Engineering Education, of which he continued as a member until his death.

Dr. Fletcher also achieved prominence as a consultant on sanitary and water supply works, and was president of the state board of health of New Hampshire continuously from 1895 to 1934. He contributed widely to technical publications, especially Transactions, Civil Engineering, and *Engineering News-Record*. One of his most recent papers was "A History of the Development of Wooden Bridges" (Transactions, Vol. 99).

Honorary degrees of master of arts, doctor of philosophy, and doctor of science had been conferred upon him by Dartmouth College, and he was also an honorary member of Phi Beta Kappa.

The esteem in which Dr. Fletcher held his membership in the Society is well illustrated by a letter written five days before his death, returning the announcement of the Annual Meeting and expressing regret that his condition as an invalid made his attendance impossible.

Water Conservation Papers Published

A valuable symposium of 13 papers or abstracts of papers on water conservation—the product of the Water Conservation Committee of the Irrigation Division—has been prepared in pamphlet form by the committee, cooperating with the Society. The committee is distributing its quota among members of the Irrigation Division and others, and an additional stock is at the disposal of the Society. Copies will be forwarded to members on request, without charge.

Since its appointment in 1929, the Water Conservation Committee has been quite active. In addition to much work by its individual members and subcommittees, it has sponsored two conferences that were attended by engineers, foresters, agriculturists, and investigators, and that served as clearing houses for research programs and results. The papers in the present report were originally presented at the second of these conferences, held in Los Angeles in March 1935. They include such subjects as studies of runoff, evaporation, erosion and erosion control, and forest influences; the use of limited water supplies for irrigation; and the conservation of flood water by spreading. This report includes those papers from the conference which are not to be published elsewhere by the Society. In view of the limited edition it is important that interested persons apply for their copies immediately.

Until July 1935 the committee was under the chairmanship of A. L. Sonderegger, who still continues as a member. The present chairman is Harry F. Blaney, and the other members are Kenneth Q. Volk (the secretary), Harold Conkling, S. T. Harding, D. A. Lane, Charles H. Lee, and Walter E. Spear, all Corporate Members Am. Soc. C.E.

State-Wide Local Section Is Organized in Kentucky

Formation of a new Local Section covering the entire State of Kentucky has been completed, and its constitution was formally approved by the Board of Direction of the Society on January 13, 1936. With this addition, the total number of Local Sections is raised to 58.

The Kentucky Section's constitution was adopted at a meeting in Louisville on December 17, 1935, at which time Grier R. Smiley was elected president; F. C. Dugan, vice-president; and Charles H. Blackman, secretary-treasurer. On January 24, 1936, the Section convened for the first time as an authorized unit of the Society. The meeting, held at Lexington, was attended by Directors Morse and Ferebee and Secretary Seabury.

Accrediting of Engineering Colleges by E.C.P.D. Under Way

The program of inspection and accrediting of engineering curricula, which the Engineers' Council for Professional Development (E.C.P.D.) offered last year to schools granting engineering degrees, has been accorded a hearty response by 34 colleges and universities in the New England and Middle Atlantic states. Inspections in these two regions were inaugurated late in 1935 and will be actively continued during the next few months. When substantial progress has been made in these areas, it is expected that the program will be extended to engineering schools throughout the United States. The accrediting program has for its purpose the best development of engineering education by identifying those institutions that offer engineering curricula worthy of recognition as such. The second objective is to build up a list of accredited engineering schools, which it is hoped may be uniformly adopted by educational, technical, and state organizations now using dissimilar lists. Twelve institutions in the New England States and 22 institutions in the Middle Atlantic States have applied for accrediting, some of which have already been visited by the delegatory committees.

E.C.P.D. is a conference of seven engineering bodies concerned with the technical, educational, and legislative interests of engineers. Its object is to enhance the status of the engineer. The constituent bodies are the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners. By unanimous action these organizations authorized E.C.P.D. to act as an accrediting agency. This it does through the activities and on the recommendations of its Committee on Engineering Schools headed by Dr. Karl T. Compton, president, Massachusetts Institute of Technology. Other major committees of E.C.P.D. give their attention to the selection and guidance of prospective engineering students, the further professional training of young engineering graduates, and the development of standards of professional recognition. Headquarters of E.C.P.D. are at 29 West 39th Street, New York, N.Y. Charles F. Scott is chairman and George T. Seabury, secretary.

In and About the Society

More than 203,000 separate pieces of mail were sent from Society Headquarters during 1935. This figure is in addition, of course, to the approximately 330,000 copies of PROCEEDINGS, CIVIL ENGINEERING, and the Year Book, which are mailed direct from the towns in which they are published. During the month of December alone, 51,000 pieces were dispatched. The largest single mailing job was handled just after Christmas, when some 15,000 copies of Manual No. 11 aggregating a ton and a half in weight, were packaged, addressed, and bagged in 74 hours. A staff of one mailing clerk and 3 assistants handles the outgoing mail. Conferences with postal authorities are frequently necessary to make sure that the most economical classification of various types of mail is being obtained.

PART OF THE AFTER-CHRISTMAS MAIL RUSH AT HEADQUARTERS

47 Bags of Copies of Manual No. 11 and 24 Bags of Literature Concerning the Annual Meeting Were Dispatched During the Last Week of the Year

* * * *

Establishment of a Student Chapter at the University of Maryland, approved by the Board of Direction on January 13, 1936, brings the total number of student groups affiliated with the Society to 113. The new Chapter, with an enrolment of about 50 juniors and seniors, is sponsored by S. S. Steinberg, M. Am. Soc. C.E., head of the department of civil engineering at the university.

* * * *

A PERSONAL invitation "to get to know us better, and to give us the privilege of knowing you better" was sent by the Buffalo (N.Y.) Local Section on New Year's day to each member of the Society resident in the Niagara area but not now belonging to the Section. "We invite you," the letter continued, "to join the Buffalo Section and put this invitation to the test, because we ourselves have found it a great stimulating aid in our lives and in our profession." To make membership attractive to as large a group as possible, the Section dues have been cut to less than half their former amount.

* * * *

Early in 1935 Texas created a state planning board that is attempting to form county planning boards all over the state. Members of the Texas Section have taken an active interest in the work, and the Section's committee on planning, surveying, and mapping, in its recent annual report, has stressed the vital importance of continuing and extending that interest. "It is obvious," the report says, "with the public interest now shown in the subject of planning, that unless the engineers of the profession take the lead in working out the details they will lose the opportunity; and it becomes an obligation for each and every one of us to know the technical features of planning so that we may talk intelligently on the subject to the non-technical business men and officials who may be selected to serve on planning boards and commissions."

* * * *

An attractive year book in mimeographed form has just been issued by the Central Ohio Section. In addition to the customary membership list, it contains the Section constitution, a résumé of the meetings held during 1935, and other valuable features. Of special interest is the description of the prizes that are awarded annually by the Section to students of civil engineering. One of these is the payment of the fee for entrance to the grade of Junior in the Society, for the senior who has stood highest in his class for the last two years. The other, donated by Mrs. Robert H. Simpson in memory of her husband, late M. Am. Soc. C.E., is a $25 award to the senior student or students writing the best thesis.

New Year Book Well Advanced

APPROXIMATELY fifteen thousand postal cards asking for changes or confirmations of addresses to be published in the forthcoming *Year Book* were sent out on December 1, 1935, together with the bills for dues for the year 1936. It is hoped that all members who have not already returned these cards will do so as soon as possible so as to be in time for the new *Year Book*.

By January 9, more than 3,800 of the cards had been returned, over 25 per cent of the total. This is an unusually good response. Many of the returned cards call for a definite change of title or address, or both, in the Society's files, indicating generally that men who have been temporarily unemployed are now again holding responsible positions. Others confirm an address already on record and, by doing so, show an active interest in Society affairs and in the accuracy of the printed list.

This year, for the first time, an additional entry has been called for on these postals, under the heading "Nature of Business." This item, not to be published, was needed to furnish certain statistics to the Audit Bureau of Circulation in connection with the advertising now carried in CIVIL ENGINEERING. The response to the new request has been so general that it is planned to use these brief statements in amplifying the index of the professional record file. Records of 10,450 members are now in this file.

This number includes deceased members as well as those now active, and obviously does not cover the whole membership of 15,000, but it does furnish a vast amount of information, which is used in various ways almost daily. The key to such information is found in an ever-growing list of "specialties," with references to the men versed in each branch of engineering. The statements on the *Year Book* postal cards will supplement this index and make it more useful.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

DELEGATES from the 42 member organizations attended the Sixteenth Annual Meeting of American Engineering Council, held in Washington, D.C., January 10 and 11, 1936, and discussed the growing evidence of unity in the profession as to the formulation and dissemination of opinion on matters of public affairs.

At the morning session at the Mayflower Hotel, January 10, President J. F. Coleman opened the meeting with an address on the essential elements in reviving the construction industry. Then followed in order a series of reports and discussions covering a wide range of subjects of timely interest to engineers.

SURVEY OF THE PROFESSION

George T. Seabury, as chairman of the engineering and allied technical committee, reported on the preparations made for the "Survey of the Engineering Profession" conducted by the Bureau of Labor Statistics of the U. S. Department of Labor. Dr. Isadore

Lubin, chief of the Bureau, reported extensively, basing his remarks on returns from more than 60,000 questionnaires, the largest survey of this kind ever conducted. He indicated that the findings, when completed, would tend to give direction to engineering education, to choice and distribution of occupation, and to compensation of engineers. It is expected that full returns will be available in the early spring. It was voted to recommend to the executive committee of Council that steps be taken toward private publication of a mass of detailed information to supplement the government report.

Dr. Leonard D. White, U. S. Civil Service Commissioner, discussed the needs for a widely extended civil service to include state and local governmental bodies as well as federal, in order to uphold the professional standards of engineers in the public service. Discussion developed that classification by position is essential in the development of a suitably paid civil service. It was voted to instruct the executive committee to take the steps necessary to put these basic concepts into action, especially in cooperation with local and state engineering societies.

ECONOMIC BALANCE TOWARD HIGHER STANDARDS

Ralph E. Flanders presented the third progress report of the committee on the interrelation of production, distribution, and consumption. In 108 classified questions and answers, there was presented a catechism on the engineers' concept of the possibilities of an economic balance in the interests of a high standard of living for all. The report was accepted with the recommendation of the committee that all delegates study it, secure local discussion on its major objectives and detailed recommendations, and report back February 1, with the plan of presenting the report publicly as soon as possible thereafter, as the engineers' contribution to our national welfare.

Charles W. Eliot, II, executive officer of the national resources committee, discussed the purposes and plans of that body in forwarding a state and local as well as a federal concept of planning. The need of approaching planning from a local and regional viewpoint was especially emphasized. It was voted to refer the bill (S. 2825) now before the Senate, providing for the continuation of the federal organization on a permanent basis, to the public affairs committee of Council for recommendations.

PUBLIC AFFAIRS REPORTS

The public affairs committee of Council, under the chairmanship of F. J. Chesterman of Pittsburgh, has been organized under a new plan during the past year with several subcommittees active in studying public problems which fall within the purview of the profession. For coordination, the subcommittee chairmen are members of the national committee and steps are being taken to make the membership of subcommittees overlap with that of similar committees of national, state, and local engineering societies. As a result of this work, the reports rendered at the Annual Meeting covered basic findings in a broad variety of fields.

The subcommittee on the administration of public works (F. M. Gunby, chairman) reaffirmed Council's past position that engineering public works of the federal government, in so far as practicable, should be concentrated under one qualified head.

The water resources committee, headed by W. S. Conant, reiterated its belief in two fundamental needs for the formulation of a water resources policy, (1) complete and coordinated basic data bearing on the subject and (2) comprehensive study of water control legislation. The establishment of a body similar to the Board of Surveys and Maps of the federal government for the correlation of government data on water resources was recommended.

As a result of the work of the aeronautics subcommittee, headed by Grover Loening, the public affairs committee adopted a report supporting aeronautical research by the colleges, disfavoring further investigations of the industry, recommending further studies toward the simplification of aircraft construction regulations, and favoring the placement of employees of the Bureau of Air Commerce under civil service.

The committee on competition of government with engineers in private practice, under the chairmanship of Alonzo J. Hammond, advocated the curtailment of competitive activities by government and the raising of consulting fees by public bodies to a basis comparable to private practice.

OTHER REPORTS

R. W. Trullinger of the U. S. Bureau of Agricultural Engineering reported on the activities of a subcommittee, made up of members of the American Society of Agricultural Engineers, a member body of Council, to forward the rural electrification program through the aid of engineers. It was voted that this work continue under a committee representative of the profession as a whole.

The Assembly received a report of the committee on patents (Dean A. A. Potter, chairman) dealing with the elimination of fraudulent practices, the use of a single signature on patent applications, the validation of joint patents, and the extension of the full rights of inventors. In addition, several specific items of legislation were presented as under consideration by the committee. It was recommended that the work of the committee be continued.

The Assembly adopted the recommendations of the executive committee that American Engineering Council establish a new committee on mapping and surveys and that it endeavor to organize public opinion as to the basic need for completing the map of the United States. It was voted to support the original Temple Act to the end that its purposes be effectuated by appropriations based upon the fundamental values of mapping and not on a relief basis.

ALL-ENGINEERS DINNER

The annual all-engineers dinner of Council, held on the evening of January 10, filled the main ballroom of the Mayflower Hotel. Some 450 engineers, representing all the major branches of the profession, were in attendance. Following the dinner, an engrossed resolution was tendered to J. F. Coleman in appreciation for his services as president of Council during the past two years. Dean A. A. Potter, the new president of Council, stressed the need for solidarity of engineering opinion. Dr. William F. Durand, chairman of the Third World Power Conference, said that the profession must concern itself not alone with technical matters but increasingly with human and social problems.

Ralph E. Flanders stated that every phase of the engineer's work is intensely human in its application and relationships, and he predicted that engineering technic will carry the nation far beyond the "miserable physical standards of 1929." The meeting was addressed also by the presidents or secretaries of each of the seven national engineering societies holding membership in Council, and by the chairman of the sixth conference of the secretaries of engineering societies.

NEW OFFICERS

Council's new president for 1936 and 1937 is Dr. A. A. Potter, dean of the schools of engineering, Purdue University, who succeeds J. F. Coleman of New Orleans. New vice-presidents are Ralph E. Flanders, president of the Jones and Lamson Machine Company, for a two-year term; and J. S. Dodds, professor of civil engineering, Iowa State College, for a one-year term.

The chairmen of the public affairs committee and of the committee on membership and representation were made ex-officio members of the executive committee of Council. The present public affairs chairman is F. J. Chesterman. C. L. Bickelhaupt, who heads the membership group, already is a member of the executive committee as vice-president of Council. In addition to the above, the executive committee includes Alonzo J. Hammond, vice-president, C. E. Stephens, treasurer, and William McClellan, chairman of the finance committee, who were reelected. Frederick M. Feiker was reelected as executive secretary.

SECRETARIES' CONFERENCE

Preceding the meeting of the Assembly of American Engineering Council, there was held on January 9 the Sixth Conference of Secretaries of Engineering Societies. Some thirty national, state, and local societies were represented. Speakers at the Secretaries' Conference included J. F. Coleman, on progress in engineering organization; Gen. R. I. Rees, of New York, on opportunities for unity among engineering organizations; and Col. J. M. Johnson, Assistant Secretary of Commerce, on the subject of the engineer in government and in business.

Washington, D.C.
January 12, 1936

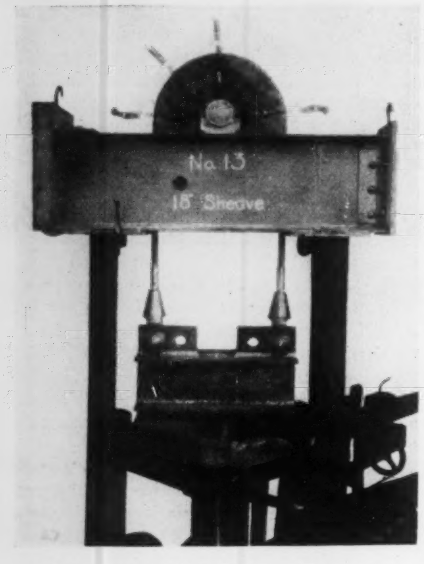
Preview of Proceedings

By HAROLD T. LARSEN, *Editor*

An unusual concentration of good discussion forced a last-minute readjustment in the contents of the January issue of "Proceedings," with the result that one of the papers previously advertised for that issue, appears as the leading paper in the February number.

BEHAVIOR OF STATIONARY WIRE ROPE IN TENSION AND BENDING

The accompanying photograph illustrates an arrangement for testing wire rope in the John Fritz Engineering Laboratory at Lehigh University. The results are described in a paper by Douglas M. Stewart, Jun. Am. Soc. C.E., entitled "Behavior of Stationary Wire Rope in Tension and Bending," which has been scheduled for the February issue of PROCEEDINGS.



LABORATORY SET-UP FOR TESTING STATIONARY WIRE ROPE

At the John Fritz Engineering Laboratory, Lehigh University

PROGRESS REPORTS

Those who were so unfortunate as to miss the Annual Meeting, held in New York City in January, must have noted in CIVIL ENGINEERING the unusual number of Progress Reports indicating the activity of various committees in their appointed fields. Those who heard the reading of these reports realized the necessity for more time to digest the thought-provoking ideas raised. Necessarily, the reports were often "skimmed" at the meeting sessions, and the abstracts published elsewhere from time to time fail to do full justice to them in some cases.

Consequently, it is intended to publish some of the reports in their entirety, where they may be discussed freely, the "grist from the mill" being used by the committee in formulating its succeeding reports.

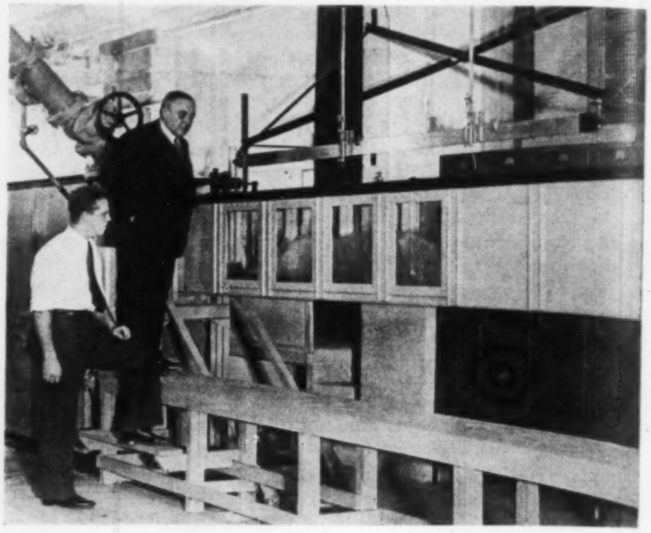
THE ANNUAL REPORT

The highlights of the annual report of the Society are given briefly elsewhere in this issue of CIVIL ENGINEERING. For the benefit of those who desire to study some item in greater detail, the report will be published in its entirety in the February issue of PROCEEDINGS. The year reported is notable in several respects and interesting from every point of view.

VARIED FLOW IN OPEN CHANNELS OF ADVERSE SLOPE

When the bed of a channel slopes downward, as one would normally expect, in the direction of flow, the slope has been characterized as "sustaining" in a forthcoming paper by Arthur E. Matzke, Jun. Am. Soc. C.E., entitled "Varied Flow in Open Channels of Adverse Slope." In channels connecting two tidal estuaries, for example, the slope of the bed is often upward in the direction of flow. The same is true of the flow of water over the silt in a reservoir, sloping backward from the dam. Such a bottom slope Mr. Matzke defines as "adverse slope." General equations for this problem were developed by B. A. Bakhmeteff, M. Am. Soc. C.E., about 1910.

In order to apply these principles, it is necessary to have the numerical values of a function similar to the varied flow function for canals of sustaining slope. The current paper offers the hitherto unpublished theoretical treatment as well as the tables of numerical values of the varied flow function for the case of adverse slope. Solutions of problems are presented to illustrate the practical use of the equations and tables. The paper is only about ten pages long and will be of interest to students of hydraulics everywhere.



VIEW OF TILTING FLUME IN FLUID MECHANICS LABORATORY
Department of Civil Engineering, Columbia University

DISCUSSION

With the constant effort made to give discussion the "right-of-way," it is gratifying to note the recent interest and activity in this respect among readers of PROCEEDINGS. In the forthcoming issue of PROCEEDINGS there will be well represented the candid opinions of many readers (some favorable and some otherwise) as pertaining to the conclusions advanced in papers published during the past half year or more.

Society Appointees

VICTOR GELINEAU, M. Am. Soc. C.E., has been appointed a member of the Executive Committee of the Waterways Division for a term of five years.

J. C. STEVENS and **ALBERT HAERTLEIN**, Members Am. Soc. C.E., will represent the Society on the American Standards Association's new program of work on Standardization of Scientific and Engineering Symbols and Abbreviations (Section Committee —Z 10).

Detroit Section to Honor Life Members

MORE than 500 years of personal engineering experiences will be reviewed by the chairman in the course of introducing guests of honor at the Detroit Section's meeting on January 31, 1936. The occasion is a special dinner in recognition of all life members of the Society resident in the state of Michigan.

The Detroiters are looking forward to making this meeting an outstanding occasion. To emphasize the all-inclusiveness of the Society, and to promote its spirit among the younger men, they have invited the Student Chapters of the University of Michigan and of Michigan State College to attend. The address of the evening, to be given by Arthur S. Tuttle, Past-President of the Society, will be on the subject of the advantages of Society friendships and associations.

Life members residing in Michigan include Maj. Gen. John Biddle, Dean Mortimer E. Cooley, Charles Y. Dixon, Alex Dow, Leslie W. Goddard, John P. Hallihan, John T. N. Hoyt, Clarence W. Hubbell, J. C. Hutchins, George Henry Kimball, Sr., Fred Morley, Charles A. Paquette, James T. Pardee, George S. Pierson, Walter P. Rice, Prof. Henry E. Riggs, and Roscoe C. Young.

A. A. Potter Heads American Engineering Council

At the annual meeting of the American Engineering Council, Dr. A. A. Potter, dean of the schools of engineering, Purdue University, was installed as president of the Council for 1936 and 1937. Dean Potter is a former president of the American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education, the Indiana Engineering Society, and the Kansas Engineering Society, which are member bodies of the national Council.

He was born in Vilna, Russia, in 1882; graduated from the Massachusetts Institute of Technology; and was awarded a doctor's degree in engineering at Kansas State College, where he later became dean of engineering. Since 1920, he has served as dean of the schools of engineering, director of the engineering experiment station, and professor of power engineering at Purdue. He is the author of textbooks, including *Farm Motors*, *Elements of Steam and Gas Power*, and *Engineering Thermodynamics* as well as numerous articles and papers published in engineering and education magazines. His record includes prominent consulting work with the government and with private firms.

News of Local Sections

ALABAMA SECTION

On December 20, 1935, the Alabama Section met at the Thomas Jefferson Hotel in Birmingham, with 11 present. During the business session the following officers for 1936 were elected: H. H. Hendon, president; R. D. Jordan, first vice-president; A. C. Polk, second vice-president; E. E. Michaels, secretary-treasurer; and W. H. Caruthers, D. H. Barber (Montgomery), C. A. Baughman (Auburn), J. H. Mayer, and R. A. Smallman, directors. At the conclusion of the meeting refreshments were served, and a smoker and program of entertainment were enjoyed.

ARIZONA SECTION

The annual meeting of the Arizona Section, held in Phoenix on November 23, 1935, took the form of an all-day session, with a business meeting in the morning, a technical program and inspection trip in the afternoon, and a dinner in the evening. During the business session J. A. Fraps was elected president of the Section for 1926. Then W. W. Lane and R. V. Leeson, chief engineer and assistant chief engineer, respectively, of the Maricopa County Municipal Water Conservation District No. 1, spoke on various features of the project. Following luncheon at the Lake Pleasant Dam, additional aspects of the project were discussed by Harry North and L. R. Dail, resident engineers, and T. R. Johnson, assistant resident engineer. After a trip over the Lake Pleasant Dam project an informal dinner was enjoyed, with E. Power Conway serving as toastmaster. The after-dinner speaker was Ralph J. Reed, Director of the Society, and the concluding feature was a debate between V. H. Housholder and Howard S. Reed. There were approximately 30 present at the business session, and about 80 at the other events.

CINCINNATI SECTION

A meeting of the Cincinnati Section was called to order at the Engineers' Club on December 9, 1935. A letter was read from J. H. Hawley, acting director of the U. S. Coast and Geodetic Survey, relative to the Section's sponsoring a local control survey with WPA funds. The ensuing discussion indicated a unanimous opinion that men are not at present available for such an undertaking, and the secretary was instructed to so inform Mr. Hawley. The speaker of the evening was Ladislas Segoe, city planning consultant, who gave a talk on national planning. The attendance was 15.

DAYTON SECTION

There were 19 present at a luncheon meeting of the Dayton Section held at the Engineers Club on December 16, 1935. During the business session W. R. Yount was elected president for the coming year, and E. O. Brown second vice-president. B. T. Schad, formerly second vice-president, was made first vice-president, and C. H. Stephens will continue as secretary-treasurer for another year. Both the outgoing and incoming presidents gave short talks. Then W. W. Morehouse, director of the Department of Water and Sewers of Dayton, showed several reels of motion pictures of the water works and sewage plants. A supplemental talk was given by Mr. Morehouse, who explained the various operations of the works in question.

GEORGIA SECTION

On December 9, 1935, a meeting of the Georgia Section was held in Atlanta. Reports of committees on employment and prizes were heard, and the annual election of officers for the coming year was held. This resulted as follows: M. T. Singleton, president; J. W. Barnett, vice-president; and J. B. Trenholm, non-resident vice-president. The secretary was instructed to notify the Senators and Representatives from the Section that the Section is opposed to government ownership of railroads and to the bills now in Congress that would restrict the railroads. A talk on the railroad situation was then given by W. L. Stanley, chief public relations officer of the Seaboard Air Line Railroad.

KANSAS CITY SECTION

There were 35 present at a meeting of the Kansas City Section held on November 27, 1935. The chief speaker on this occasion was Walter E. Jessup, Field Secretary of the Society, who talked on the subject of Society activities and invited discussion on what, if any, "welfare" or "social" projects the Society should develop to broaden its field. At the meeting of the Section held on December 10 the following officers for 1936 were elected: Robert P. Woods, president; T. J. Samuel, first vice-president; J. F. Brown, second vice-president; and A. B. Taylor, secretary-treasurer. A talk on excavation work on the Fort Peck Dam spillway was then given by A. D. Harvey, general manager of Spillway Builders, Inc. There were 25 present.

MILWAUKEE SECTION

A meeting of the Milwaukee Section was held at the City Club on August 29, 1935, with 16 in attendance. After a business session the speaker of the evening, A. Lawrie Kurtz, Wisconsin State Administrator to the Public Works Adminstration, was introduced. He spoke on the topic, "Aims and Activities of the PWA," which elicited protracted discussion from the floor.

NEW MEXICO SECTION

A joint meeting of the New Mexico Section and the New Mexico State College Student Chapter was held at Las Cruces, N.M., on April 13, 1935. The speakers at this all-day session were Lt. J. R. Noyes, H. M. Milton, L. R. Fiock, W. E. Stockwell, Charles M. Stokes, G. R. Quesenbury, Ralph Charles, and E. L. Barrows. On May 16, 1935, there was a meeting of the Section at Albuquerque, the speakers being C. A. Anderson, J. D. McGuire, and Col. C. M. Adams. On June 26, 1935, a special dinner meeting was held in Santa Fe in honor of George T. Seabury, Secretary of the Society, who spoke on the various activities of the Society. At the first meeting of the fall, held in Albuquerque on September 11, 1935, E. L. Hardy, of the U. S. Weather Bureau, explained in detail the different services available to the public. A two-day joint session of the Section and the University of New Mexico Student Chapter took place in Albuquerque on October 11 and 12, 1935. A banquet and program of entertainment were enjoyed by 45 on the evening of the first day. The principal speakers on the technical program, presented on the second day of the meeting, were W. C. Wagner, of the civil engineering staff of the University of New Mexico; E. L. Barrows, president of the Section; and Leon T. Eliel, vice-president of the Fairchild Aerial Surveys Inc., of Los Angeles. At a meeting of the Section held in Santa Fe on November 13, 1935, an interesting talk on "Soil Conservation in the Southwest" was given by G. T. Howell, of the U. S. Soil Conservation Service.

NORTH CAROLINA SECTION

Leslie R. Ames has resigned as president of the North Carolina Section, and D. S. Abell, formerly vice-president, has assumed his duties.

PANAMA SECTION

Officers for 1936 were elected at the annual meeting of the Panama Section held at the Miramar Club in Panama City on December 9, 1935. The results were as follows: H. G. Arango, president; R. C. Jones, first vice-president; and R. L. Klotz, second vice-president. At the conclusion of the business session a paper on "The Design and Reconstruction of Dock 15, Balboa, C.Z.," was read by M. R. Alexander, assistant engineer in the Division of Office Engineer of the Panama Canal.

PORTLAND (ORE.) SECTION

On December 20, 1935, a meeting of the Portland (Ore.) Section was held in the University Club. There were 36 present. The secretary was requested to write a letter on behalf of the Section to Marshall N. Dana, urging that the Regional Planning Commission encourage projects for the mapping of the country. The first speaker was Ivan C. Crawford, Director of the Society and dean of the College of Engineering of the University of Idaho, who discussed Society affairs. Those appearing on the technical program were C. F. Thomas, principal assistant engineer of the Spokane, Portland and Seattle Railway, and Gage Haselton, assistant engineer for the Southern Pacific Railroad. The former spoke on the subject, "Transverse Fissures in Steel Rails," and the latter explained a method of detecting transverse fissures by the use of a "detectocar." An enthusiastic discussion from the floor followed.

PUERTO RICO SECTION

At the annual meeting of the Puerto Rico Section held on December 10, 1935, the following officers were elected for 1936: Rafael A. Gonzáles, president; Ricardo Skerrett and Emilio S. Jiménez, vice-presidents; and Antonio S. Romero, secretary-treasurer.

SAN FRANCISCO SECTION

A special meeting of the San Francisco Section was held on November 19, 1935, for the purpose of discussing subjects of social and economic interest to the Section. There were 65 present. On December 17, 1935, Samuel B. Morris, executive head of the civil engineering department of Stanford University, spoke on the design and construction of Morris Dam. At this session Walter L. Huber was elected president, and Fred C. Scobey vice-president.

TACOMA SECTION

There were 34 members and 60 guests present at a meeting of the Tacoma Section called to order at the Bonneville Hotel on December 9, 1935. During the business session the following officers for 1936 were elected: J. P. Hart, president; O. H. Hallberg, vice-president; G. M. Thayer, secretary-treasurer; and Fred Dunham, director. E. C. Dohm, of the Board of Examiners for the Registration of Engineers in the State of Washington, spoke briefly of the work of the board. The technical program included talks on the Bonneville Dam project by B. E. Torpen, senior engineer, Corps of Engineers, U. S. Army, on the Bonneville project; Howard Cooper, associate engineer in charge of power house design on the project; E. B. Miller, associate engineer in charge of mechanical design; and Hollis Johnson, senior architect in charge of architectural features.

TEXAS SECTION

The Texas Section held its annual meeting at Beaumont, Tex., on November 8 and 9, 1935. During this session officers for the ensuing year were elected as follows: W. H. Meier, president; W. W. McClendon, first vice-president; D. E. Proper, second vice-president; and J. T. L. McNew, secretary-treasurer.

Student Chapter Notes

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

There were over 100 present at a meeting of the Agricultural and Mechanical College of Texas Student Chapter held on December 10, 1935. The guests of honor and speakers were T. B. Warden, contact member for the Student Chapter; John Focht, professor of civil engineering at the University of Texas; George Myers, president of the Texas Section; and Walter E. Jessup, Field Secretary of the Society. The main address was given by Mr. Jessup, who outlined the history and activities of the Society, describing particularly the requirements for membership and advancement. The other speakers briefly discussed the work of the Society and stressed the value of membership to young engineers.

OHIO STATE UNIVERSITY

Early in December the Ohio State University Student Chapter began publishing a paper called *The A.S.C.E. News* for the purpose of stimulating interest in the Society and promoting friendly relations between the faculty and students. It is planned to issue this mimeographed sheet every week.

RENSSELAER POLYTECHNIC INSTITUTE

On November 21, 1935, David B. Steinman, consulting engineer of New York City, addressed a meeting of the Rensselaer Polytechnic Institute Student Chapter. Dr. Steinman, who is president of the National Society of Professional Engineers, spoke on the topic, "New Developments in Bridge Engineering," which was enthusiastically received.

UNIVERSITY OF NEW MEXICO

The University of New Mexico Student Chapter entertained the members of the New Mexico Section of the Society on Friday and Saturday, October 11 and 12, 1935. On Friday evening a banquet and program of entertainment were enjoyed. After a short business meeting, on Saturday morning, a talk on road oils was given by W. C. Wagner, professor of civil engineering at the university. This was followed by a lecture on aerial photographic mapping and an inspection trip to the airport to inspect the plane and camera used in making these photographs. On November 27 the Chapter sponsored a dance for the benefit of the engineering college of the university, which proved highly successful.

UNIVERSITY OF NEW MEXICO STUDENT CHAPTER

WASHINGTON UNIVERSITY (COLLIMATION CLUB)

A meeting of the Washington University Student Chapter (Collimation Club) was held on December 11, 1935, with 16 present. The feature of the occasion was the presentation of an illustrated lecture on the Holland Tunnel, which was loaned by the Society. This lecture was very enthusiastically received by the members.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for March

WIDE INTEREST in the well-rounded program presented at the Eighty-Third Annual Meeting of the Society, held in New York, N.Y., January 15 to 18, 1936, insured its success. The latest developments in the civil engineering field were described in over a dozen noteworthy papers.

Included among these papers are five comprising a symposium on recent advances in construction equipment and methods. The others deal with technical developments in the highway, city planning, and structural fields. The subject matter of these addresses will be brought to the attention of every member, in as complete a form as space will permit, in the March issue of CIVIL ENGINEERING.

The facilities of the March number being thus taken up, some of the reports of committees will of necessity be allocated to PROCEEDINGS. In this way it is believed that a better opportunity will be provided for members to discuss the reports, while adequate space can still be reserved in CIVIL ENGINEERING for abstracts of all the meeting papers.

N.Y. Licensing Requirements to Be Raised Next Year

THE NEW YORK state board of examiners for professional engineers is receiving a flood of applications in anticipation of the January 1, 1937, deadline. On that date important changes raising the qualification requirements will go into effect. At present applicants must have completed an approved four-year high school course or its equivalent, and must have had eight years or more of practical engineering experience of a grade and character satisfactory to the board. After the first of next year applicants (1) must submit evidence of graduation from a college or school of engineering registered by the department as maintaining satisfactory standards, followed by 4 years of satisfactory experience in engineering work before admission to the written examination; or (2) in lieu of graduation they must present evidence of at least 12 years of practical engineering experience of a grade and character satisfactory to the board before admission to the examination. Moreover, the written examinations prescribed for all candidates will be increased from one subject to three, including an engineering report.

The State Department of Education, in charge of the administration of the licensing laws, has ruled that any person making application prior to January 1, 1937, and submitting evidence of a record that may reasonably be supposed to satisfy the present requirements, will be permitted to qualify under them, even though all the necessary evidence may not be submitted until after the deadline date.

At the December 1935 meeting of the board of examiners, 433 applications were considered, and 234 applicants were scheduled for examination.

Washington Award to Go to C. F. Kettering

THROUGH the Western Society of Civil Engineers, announcement is made of the election by the Washington Award Commission of Charles F. Kettering as the recipient of the Washington Award for 1936. This award is made annually "as an honor conferred upon a brother engineer by his fellow engineers on account of accomplishments which preeminently promote the happiness, comfort, and well-being of humanity," and consists of a bronze medal or other work of art. The commission consists of nine members of the Western Society of Civil Engineers and two members each from the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. The presentation will be made during the last week in February, at a joint meeting of the engineering societies represented on the commission.

CHARLES F. KETTERING

Mr. Kettering, vice-president and director of General Motors Corporation, is well known as the inventor of the Delco starting, lighting, and ignition system for automobiles, the Delco-Light System, the ignition on the Liberty motor, ethyl gasoline, and numerous other devices and improvements. As general director of the General Motors Research Laboratories, he is also well known in engineering research.

Edison Memorial Fund

ON FEBRUARY 10 the Thomas Alva Edison Foundation will begin a world-wide campaign for the collection of an Edison memorial fund. Moneys received are to be applied to aid youth through education in the advancement of science, to preserve Edison's library and laboratory at West Orange, N.J., to erect a fireproof building to house all the original apparatus and the records of Mr. Edison, to make permanent the present temporary tower at Menlo Park, and to provide a final resting place for Mr. Edison.

The Foundation is a permanent organization set up and incorporated by the International Edison Memorial Committee. It has no political or commercial connections, representing rather the technical side of the various industries developed by Mr. Edison. Ernest M. Van Norden, M. Am. Soc. C.E., represents the Society as a director of the Foundation.

Wise and Otherwise

ANOTHER ALPHABETICAL problem in long division by Professor Abercrombie is presented in this issue. Each letter in this puzzle represents a numeral, and when the letters are arranged in the order corresponding to the sequence 1 to 0, the result is a word pertaining to space occupied.

```
EM)VECIR(OUT
   VLC
    LCI
    OEC
     UIR
     UMM
      UL
```

January's problem involved the solution of the following expression:

```
RUA)CCYAL(DAS
    IHC
    YIRA
    YAYL
     RYCL
     RYCL
```

This may be attacked in a number of different ways. For example, it will be noted that A multiplied either by A or by S gives a number ending in L. From this, L must be either 4 or 6. Substituting first one and then the other of these values, resulting values for A and C require that L be 6. A is then 4, S is 9, C is 8, and D is 2. The key to the problem quickly follows, in the following form:

H Y D R A U L I C S
0 1 2 3 4 5 6 7 8 9

Suggestions for other problems, accompanied by solutions, should be addressed to the editor.

The Water Exhibit at the San Diego Exposition

By D. A. Elliott

The Metropolitan Water District of Southern California, Los Angeles, Calif.

Among the many interesting exhibits on view during the past summer at the California Pacific International Exposition in San Diego, Calif., was a huge animated diorama depicting the story of water in the southern part of California. The Metropolitan Water District of Southern California, the Department of Water and Power of the City of Los Angeles, and Imperial County collaborated in presenting this exhibit, which shows how Southern California, although formerly a desert region, is being adequately supplied with water.

The diorama, believed to be the largest ever built and operated, is in the form of a relief map 100 ft long and approximately 20 ft wide, representing a length of 600 miles and a width of 300 miles. The relief map is viewed from the ocean side and is completely enclosed at the back and both ends by a cyclorama, or painted backdrop, some 20 ft in height, giving the effect of a vast expanse of land and sky. The entire scene is painted to give realistic desert effects, and city and urban developments are represented.

The exhibit (shown in a photograph) depicts the entire southern end of the state, and is arranged to emphasize the three principal water projects in that area: The Owens River Aqueduct of the City of Los Angeles, having its source in the snow-capped Sierras 250 miles to the north; the Colorado River Aqueduct, which is to bring water into the coastal plain of Southern California from the Colorado River 300 miles to the east; and the All-American Canal, being constructed to supply Colorado River water to the Imperial Valley. The Boulder Dam project, with its radiating power lines and water storage facilities, forms a part of the diorama.

Main aqueduct lines, which are indicated by translucent inserts of celloglass in the surface of the diorama, are illuminated from below by a variable light which simulates the flow of water. Distribution lines are identified by rows of pin-bulb electric lights in different colors. The giant transmission lines from Boulder Dam are also illuminated by lines of pin-bulb lamps. The exhibit is illuminated by banks of flood lights concealed in the overhead valance, controlled both in color and intensity by motor-driven cycle dimmers. In addition to the general lighting, spotlights are provided for emphasizing individual features as they are described to the public. Lights under the canals and the various groups of pin-bulb lamps are likewise subject to separate control.

A "robophone" consisting of an electrically driven phonograph and a group of telephone relays, automatically presents the discourse, describing the principal features of the exhibit in synchronism with the 56 operations of the lights. A large switchboard and some five miles of wiring, handling a load of 40 kw, controls the thousands of lights, flashers, and dimmers. The entire cycle, which takes place in a period of about 12 minutes, is set in motion merely by throwing an electric switch.

A fanfare of trumpets from above the robophone calls the visitors to the platform overlooking the diorama, and the discourse is delivered through six loudspeakers behind the backdrop. During the introduction, the scene gradually fades from bright sunlight to dusk, with the warm glow of a desert sunset, and then to night, as a blue evening haze settles down over the scene. Attention is first directed to the Los Angeles Aqueduct at the left side of the map, which simultaneously becomes a shimmering ribbon of light. Then the distributing system of Los Angeles is outlined with red pin-bulb lamps.

Next the Colorado River Aqueduct is graphically presented in the same way. A shimmering ribbon of light starts at the Colorado River and traces the path of conduits, canals, and siphons over the mountains, across the desert, and through long tunnels to the Cajalco Reservoir near Riverside. A distribution system indicated by lines of green pin-bulb lamps spreads out from this reservoir to the 13 cities composing the Metropolitan Water District, which in turn are illuminated as they are mentioned.

The third great water development is next presented—the All-American Canal in the Imperial Valley. This canal, with its tributaries and the Salton Sea, is illuminated in the same manner and the important features of the project are described. The Imperial Valley with its fertile farm lands is outlined by a green spotlight hidden above.

Other features of interest, such as Boulder Dam and its radiating power transmission lines, leading to pumping plants and to the City of Los Angeles, are illuminated and described in turn. As the discourse nears its end, the lights gradually go on, producing a realistic sunrise on the desert.

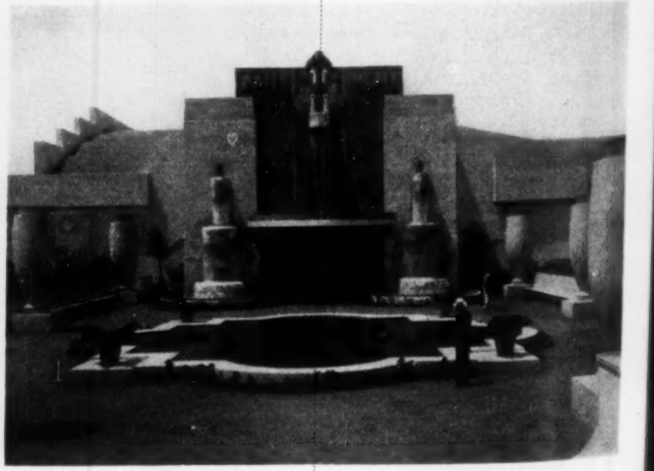
This exhibit proved to be one of the major attractions of the exposition. On November 11, a total of 5,780 performances had been given to 1,200,000 visitors.

The diorama is along the south wall of the Water Palace, the main entrance to which is shown in an accompanying photograph. A reflecting pool in a sunken forecourt is surrounded by a group of large urns. Huge pylons support a series of basins, increasing in size from the top downward, with water overflowing from one to another to form continuous 40-ft cascades. At night these cascades are illuminated by banks of red, green, blue, and amber underwater projectors in each basin and pool.

Sponsors of the exhibit for their respective organizations are: W. P. Whitsett, Chairman of the Board of Directors of the Metropolitan Water District; F. E. Weymouth, M. Am. Soc. C.E., General Manager and Chief Engineer of the Metropolitan Water District; H. H. Van Norman, M. Am. Soc. C.E., Chief Engineer of the Bureau of Water Works and Supply of the City of Los Angeles; and B. A. Harrigan, representing Imperial County.

The exhibit was designed and installed under the direction of G. E. Farmer, V. J. Meyer, and the writer, of the Metropolitan Water District; and H. A. Price and Walter Clayberg, of the Department of Water and Power, of the City of Los Angeles.

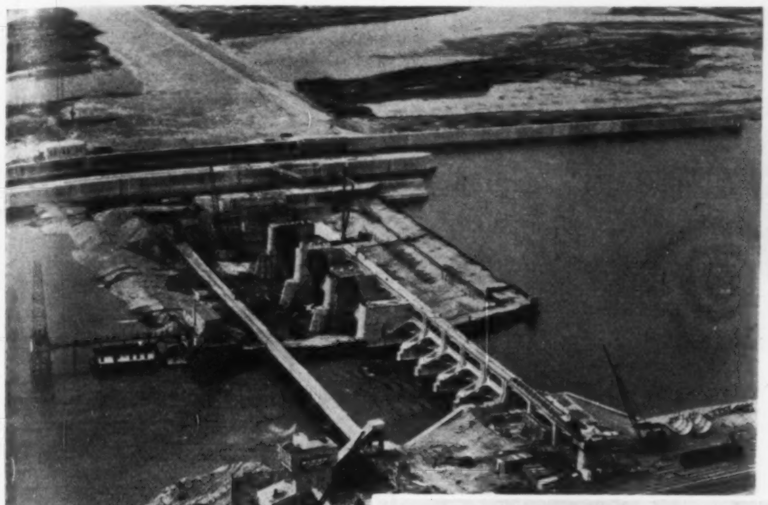
General View of Diorama



Main Entrance to the Water Palace

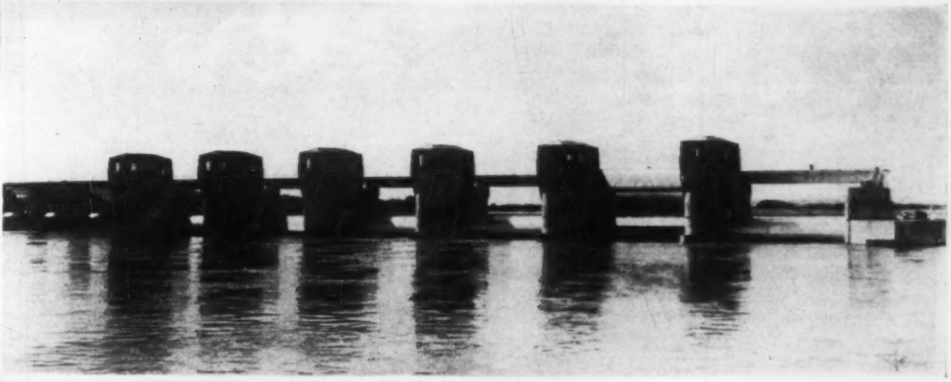
Regulating Flow of the Father of Waters

Views of Navigation Dams on the Upper Mississippi

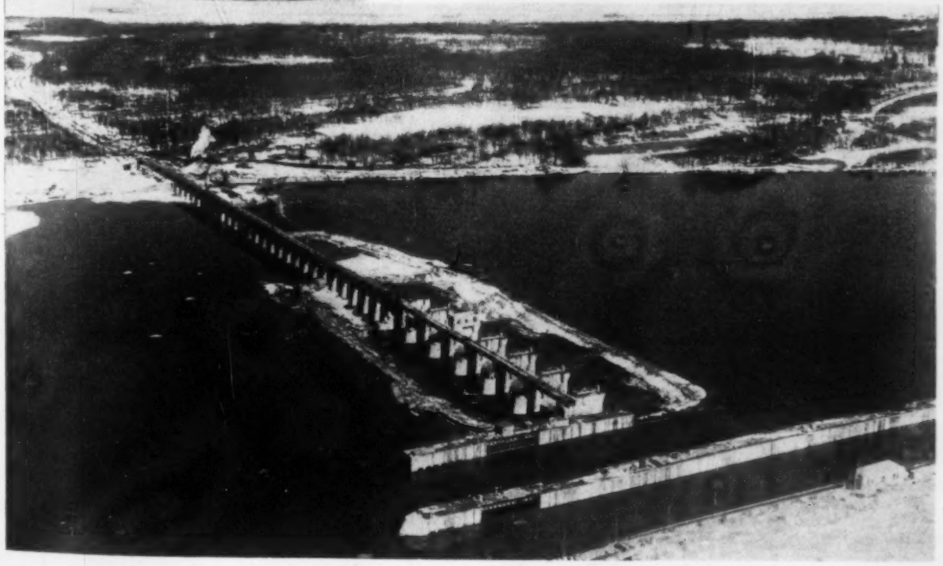


GENERAL VIEW OF CONSTRUCTION ON DAM NO. 5-A, NEAR WINONA, MINN.
Starting Near Shore, the Structures Include Tainter Gates, Roller Gates, Locks, and Earth Embankment

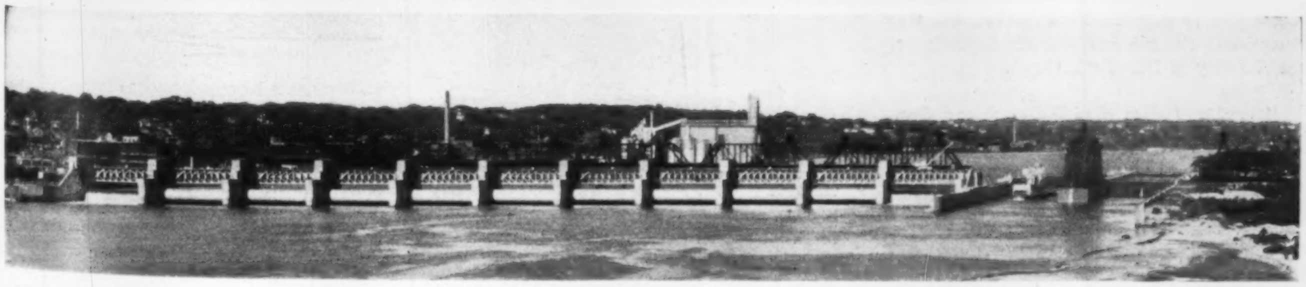
LOCK NO. 11, NEAR DUBUQUE, IOWA, FROM EAGLE POINT PARK
Second Lock Under Construction Beyond



COMPLETED ROLLER GATE OF DAM NO. 4, NEAR ALMA, WIS.
Showing Operating Houses and One Roller in Raised Position



LOCK AND DAM NO. 5, NEAR FOUNTAIN CITY, WIS.
Shows Roller Gate Construction Within Cofferdam. The Following Day This Work Was Flooded



DOWNSTREAM VIEW OF LOCKS AND DAM NO. 15, AT ROCK ISLAND, ILL.
Gates in Echelon Arrangement; Auxiliary Lock in Operation

Brief Notes from Here and There

The Institution of Civil Engineers of Ireland celebrated its centenary anniversary in 1935. This organization, although comparatively small, has had a number of famous engineers on its rolls, and has issued its *Transactions* regularly since 1845. It was in that publication that Robert Manning's classic paper on the flow of water in open channels and pipes first appeared, in 1890.

* * * *

The president and council of the Institution of Civil Engineers (of Great Britain) announce that members of kindred engineering and scientific societies throughout the world will be accorded, while in England, the privileges of attending the meetings of the Institution and of using the Institution library and reading rooms. If they desire it, such visitors will also be presented with letters of introduction to members of the Institution to enable them to visit engineering works throughout the country. Similar courtesies are extended by the American Society of Civil Engineers to foreign visitors.

* * * *

From Berlin come the Christmas and New Year's greetings of the Verein deutscher Ingenieure, addressed to the Society. The card pictures the first German railroad train, which made its initial run between Nürnberg and Fürth—a distance of about four miles—an even century ago.

* * * *

A special lecture course on recent developments in soil mechanics will be given at Harvard University by Dr. Charles Terzaghi, M. Am. Soc. C.E., beginning on February 5, 1936. Many of the lectures will deal with the practical applications of soil mechanics to problems in earth and foundation engineering, and should be especially valuable to practicing engineers. Arrangements have been made to permit attendance without payment of tuition fees, provided the course is not elected for credit.

NEWS OF ENGINEERS

From Correspondence and Society Files

Robinson D. Buck has become associated with the firm of Henry Wolcott Buck, formerly Henry R. Buck, Inc. He was previously in the engineering department of the city of Hartford, Conn.

John B. Dean, division engineer, Supply and Purifying Section, Water Division, City of St. Louis, Mo., has been appointed water commissioner to succeed C. M. Daily.

H. G. Sours has been elected chairman of the Ohio state board for the registration of engineers.

Irving Laurence Johnson is now associate bridge construction engineer in the California State Department of Public Works, with headquarters in Los Angeles. He was previously assistant bridge construction engineer on the San Francisco–Oakland Bay Bridge.

Lenox R. Lohr

Lenox R. Lohr has been made president of the National Broadcasting Company, succeeding Merlin H. Aylesworth who has resigned. Mr. Lohr was formerly general manager and vice-president of A Century of Progress Administration and editor of the *Military Engineer*.

Samuel J. Ott has been appointed division engineer in charge of the New York Engineering Department of the American Bridge Company, with offices at 71 Broadway, New York City. He has assumed the duties of J. E. Wadsworth, assistant chief engineer, who is about to retire on pension.

Lewis B. Stillwell

Lewis B. Stillwell has been awarded the Edison Medal for 1935 by the American Institute of Electrical Engineers for "distinguished engineering achievements and his pioneer work in the generation, distribution, and utilization of electric energy." This medal is awarded annually for unusual achievement in the electrical field. Mr. Stillwell entered a consulting practice in New York City in 1900, and since 1927 he has been consultant to the Port of New York Authority.

H. Oakley Sharp, professor of geodesy and railroad engineering at Rensselaer Polytechnic Institute, was recently made a member of the educational division of the American Road Builders Association.

Gustave R. Lukesh, Colonel, Corps of Engineers, U. S. Army, has been appointed engineer of the Eighth Corps Area and transferred from New York City to Fort Sam Houston, Tex.

A. L. Alin, of the U. S. Engineer Office, was recently transferred from the Zanesville District to the Huntington (W.Va.) District, where he is in charge of the design of the Bluestone Reservoir project.

Frederick Yancy Parker, formerly of the Corps of Engineers, U. S. Army, retired on December 1, 1935, to make his home in Edgewater, Colo.

Alexander Gray has been appointed acting manager of the port of St. John, Canada, by the Central Harbor Board. This board was recently organized to direct all the ports of Canada, replacing the various port commissions that had been functioning previously. Mr. Gray was chief engineer and general manager of the St. John (N.B.) Harbor Commission, until the abolition of that commission.

C. M. Daily recently resigned as water commissioner of the City of St. Louis to become vice-president of the Missouri Engineering and Contracting Company of that city.

Fred W. Blaisdell has resigned as technical assistant at Massachusetts Institute of Technology to become junior soil conservationist in the Soil Erosion Service of the U. S. Department of Agriculture. He is at present stationed at State College, Pa.

H. S. Riesbol has been transferred from the section of soil erosion investigations of the Soil Conservation Service at Guthrie, Okla., to the section of watersheds and hydrologic studies of the same Service, with headquarters at Coshocton, Ohio.

F. H. Frankland recently became chief engineer of the American Institute of Steel Construction, of New York, N.Y. He was previously director of the engineering service of the same organization.

DECEASED

William Estey Boden (Jun. '30), who was with the Standard Oil Company of California, died recently in San Francisco at the age of 29. He was born in Watsonville, Calif., and graduated from Stanford University in 1928, with the degree of A.B. in engineering. In 1930 he received the C.E. degree from the same institution. From the time of his graduation until his death, he was with the Standard Oil

Company of California, engaged in drafting, designing, surveying, and construction work.

William Driscoll (Assoc. M. '16) died at St. Inigoes, Md., on December 6, 1935. He was born in New Britain, Conn., on May 23, 1870, and studied civil engineering at Norwich University. His career, which was largely devoted to the survey, design, and construction of railway and transmission lines, took him to many foreign countries, including Mexico, Spain, the West Indies, and South America. In 1917 he became connected with the International Railways of Central America, with headquarters at Santa Ana. He remained with this organization until 1923 when he retired to his home at St. Inigoes.

Robert Fletcher (Affiliate '74) director emeritus of the Thayer School of Civil Engineering at Dartmouth College, died in Hanover, N.H., on January 7, 1936, at the age of 88. At the time of his death his period of connection with the Society was longer than that of any other living member. A brief account of his career appears in the "Society Affairs" department of this issue.

Martin Gay (M. '89) died at his home in New York City on November 23, 1935. He was born at New Brighton, Staten Island, N.Y., on May 15, 1854, and graduated from Massachusetts Institute of Technology in 1877, with the degree of B.S.C.E. For many years he was employed by the New York City Department of Public Works on surveys of the Bronx River, canal lines between the Croton and Housatonic rivers, reservoirs and pipe-lines for the construction of Kensico Dam, and other projects. In 1921 he retired from active engineering work.

Edward Gillette (M. '89) for many years an authority on railroad engineering, died at Sheridan, Wyo., on January 4, 1936, at the age of 81. He was born in New Haven, Conn., and graduated from the Sheffield Scientific School of Yale University in 1876. In 1884, after six years devoted to topographic work for the U. S. Geological Survey and the Rio Grande and Western Railroad, he became a locating engineer for the Chicago, Burlington and Quincy Railroad. In 1895 he was sent by the federal government to locate a railway in Alaska, and later he was chosen by President Taft to head a committee whose findings were the basis of many irrigation laws in the West. In 1906 Mr. Gillette began a four-year term as treasurer of the State of Wyoming. Since 1911 he has been engaged in consulting practice at Sheridan.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

Adolph Lietz (Affiliate '22) of the A. Lietz Company of San Francisco, Calif., died on June 16, 1935, at the age of 75. He was born in Luebeck, Germany. Since 1882 he was president and general manager of the company which bears his name. The A. E. Lietz Company manufactures engineers' field instruments.

Frederick William Mills (Assoc. M. '22), senior highway engineer of the U. S. Bureau of Public Roads, died at his home in Washington, D.C., on December 17, 1935. He was born in Quebec in 1872 and graduated from the Leavenworth officers school. In his youth Mr. Mills served as an officer in the British mercantile marine and later as lieutenant in the U. S. Army. In 1918 he went with the Bureau as assistant highway engineer. During the past 20 years Mr. Mills made important contributions to research in highway engineering and wrote numerous articles for technical publications.

Asa Emory Phillips (M. '01), consulting engineer, died in Washington, D.C., on January 1, 1936. He was born at North Arlington, Va., on September 8, 1866, and graduated from Lehigh University in 1890, with the degree of C.E. From 1889 until 1917 he was connected with the Sanitary Engineering Department of the District of Columbia. In 1917 he was assigned by the War Department as a member of the Council of National Defense, and supervising engineer at Newport News, Va. In 1927 he was a delegate to the World Congress of Engineers at Tokyo and was a member of the board of engineers who planned greater Shanghai.

Philip Lanahan Welker (Jun. '30), field engineer for Sanford and Brooks Company of Baltimore, Md., died in New Orleans, La., on December 16, 1935. He was born in Baltimore on June 23, 1905, and graduated from Cornell University in 1928, with the degree of civil engineer. From June 1929 to January 1930 he was an inspector in the U. S. Engineer Department. He then joined the staff of Sanford and Brooks Company. Here he remained until his death, serving as field engineer on the construction of numerous bridge, pier, and building projects in Maryland.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From December 10, 1935, to January 9, 1936, Inclusive

Additions to Membership

Armento, William Joseph (Jun. '35), Rodman, Park Dept. (Res., 861 Kinsella Ave.), New York, N.Y.

Bagdadi, Mahmut (Jun. '35), Sari Yakup Mah., Adana, Turkey.

Bailiff, Norman Lynn (Jun. '35), Designer and Detailer, Carter Equipment Co. (Res., 3844 Thompson St.), Kansas City, Mo.

Berg, Paul Henry (Jun. '35), With U. S. Geological Survey, 338 Tenth St., Idaho Falls, Idaho.

Birch, George Washington (Jun. '35), Care, U. S. Bureau of Reclamation, Duchesne, Utah.

Bjornstad, Trygve (Jun. '35), 104 North 101st St., Seattle, Wash.

Blagg, John Dorman (Assoc. M., '35), Field Engr., TVA, Murphy, N.C.

Blaschke, Edwin Henry (Jun. '35), Sealy, Tex.

Bracht, Berend, Jr. (Jun. '35), 1833 M St., N.W., Washington, D.C.

Bratschi, William George (Assoc. M. '35), Junior Engr. for State Engr., Box 1515, Santa Fé, N.Mex.

Britten, Hudson Neil (Jun. '35), Surv., Geophysical Research Corporation, Three Rivers, Calif.

Brown, Edward Stickney, Jr. (Jun. '35), 1 Spring St., Newburyport, Mass.

Burns, Bennett Winfield (Jun. '35), 944 Bayland Ave., Houston, Tex.

Busse, Robert Ramsey (Jun. '35), 529 Oxford St., Crafton P.O., Pittsburgh, Pa.

Caneva, Bruno (Jun. '35), 4174 Edson Ave., New York, N.Y.

Carman, Harry Blaine, Jr. (Jun. '35), 22 Fontaine Ave., Bloomfield, N.J.

Coan, John Michael, Jr. (Jun. '35), 563 East 38th St., Baltimore, Md.

Comer, John William (Jun. '35), Box 142, Alcova, Wyo.

Corey, John Burhyte Wilmot, Jr. (Jun. '35), 2202 First Ave., West, Seattle, Wash.

Corwin, Merton Dudley (Jun. '35), 180 East Mapledale Ave., Akron, Ohio.

Couts, Robert James (Jun. '35), Engr., City

Highway Dept. (Res., 28 North Union St.), Akron, Ohio.

Cranley, Edward Patrick (Jun. '35), 640 Waveland Ave., Chicago, Ill.

Czel, James Eugene, Jr. (Jun. '35), Levelman, State Highway Dept., 748 North Main St., High Point, N.C.

Dahl, Leslie Howard (Jun. '35), 213 Eighty-Eighth St., Brooklyn, N.Y.

Dallas, Alexander Fraser (Jun. '35), Box 113, New Dorp, N.Y.

Davidson, Leo (Jun. '35), Care Dept. of Agriculture, SCS, Photogrammetric Div., Washington, D.C.

DeMeo, Lawrence John (Jun. '35), Junior Office Engr., J. S. Watkins (Res., 304 South Limestone St.), Lexington, Ky.

Dickson, Thomas John (Assoc. M. '35), Structural Designer, Stone & Webster Eng. Corporation, Boston (Res., 7 Benson St., Brighton), Mass.

Dodds, Arthur Earnest William (Jun. '35), With Farwest Speedways, Inc.; 107 East 52d St., Seattle, Wash.

Dominy, John Arthur (Jun. '35), Supt. of Building Constr., Perlman & Wortmann, Inc.; 33 South Bay Shore Ave., Bay Shore, N.Y.

Douglas, Walter Spalding (Jun. '35), 1423 Stratton Ave., Nashville, Tenn.

Downing, Robert Woodling (Jun. '35), 241 Dickson Ave., Ben Avon, Pa.

Drizen, Aaron (Jun. '35), 308 Morris St., Philadelphia, Pa.

Elstad, Eivind Glestad (Assoc. M. '35), Structural Designer, Bareny-Ahlers Constr. Corporation, 101 Park Ave. (Res., 401 West 118th St.), New York, N.Y.

Elwin, Elmer Hill, Jr. (Jun. '35), Care, U. S. Biological Survey, Box 624, Devils Lake, N.Dak.

Emerson, Charles Edward (Jun. '35), 165 Laurel Ave., Arlington, N.J.

Enger, Walter Melvin (Jun. '35), Junior Engr., Bureau of Reclamation, Room 440 Custom House, Denver, Colo.

Eschen, Franklin William, Jr. (Jun. '35), Box 212, Sloatsburg, N.Y.

Fenstermaker, John Ralph (Jun. '35), With State Highway Dept. (Res., 146 East 44th St.), Indianapolis, Ind.

Fisher, Jack Farrington (Jun. '35), Junior Engr., Standard Oil Co. (Res., 1528 Sutter St.), San Francisco, Calif.

Flint, Raymond Eugene (Jun. '35), 868 Newport Ave., Webster Groves, Mo.

Friedlaender, Hermann (Jun. '35), 404-A Atkinson Hall, Mass. Inst. Tech., Cambridge, Mass.

Frisch, Solomon (Jun. '35), 4711 Twelfth Ave., Brooklyn, N.Y.

Fusco, James John (Jun. '35), 50 Prospect St., Glens Falls, N.Y.

Graham, Theodore Roosevelt (Jun. '35), Project Engr., State Dept. of Roads and Irrig. (Res., 1415 Pawnee St.), Lincoln, Nebr.

Grill, William Henry (Jun. '35), 328 East 180th St., New York, N.Y.

Halprin, Benjamin (Jun. '35), 1855 Eightieth St., Brooklyn, N.Y.

Hartman, John Paul (Jun. '35), Asst. Engr., U. S. Engr. Office (Res., 629 Musselshell St.), Fort Peck, Mont.

Hayden, George Gunderson (Jun. '35), 9 Florida Ave., Bronxville, N.Y.

Heaman, William McPherson (Jun. '35), Care, National Tank & Pipe Co., Kenton Station, Portland, Ore.

Hnot, Walter Rudolph (Jun. '35), 529 East 6th St., New York, N.Y.

Hofmann, Arnold (Jun. '35), 135 Christie Ave., Clifton, N.J.

Hollis, Edward Poole (Jun. '35), 544 Lowell Ave., Palo Alto, Calif.

Howard, James Murray (Jun. '35), 1825 Berryhill St., Harrisburg, Pa.

Hunt, Lawrence Halley (Jun. '35), 1011 West Boulevard, Rapid City, S.Dak.

Jancik, Edward Charles (Jun. '35), Project Engr., Liberty County Highway Dept., Box 416, Liberty, Tex.

Jennings, George Henry (Jun. '35), Marcell, Minn.

Johnson, Alfred Massey Fisher (Jun. '35), Draftsman, TVA, Box 181, Chattanooga, Tenn.

Johnson, Lee Harnie, Jr. (Jun. '35), 1313 Adams, Vicksburg, Miss.

Jones, Carl Roemer (Jun. '35), 1416 South Hayworth Ave., Los Angeles, Calif.

Jones, Morris Shelley (M. '35), Chf. Engr. and Gen. Mgr., Pasadena Water Dept., 319 City Hall (Res., 1250 North Holliston Ave.), Pasadena, Calif.

Jordan, Donald Thomas (Jun. '35), Cable Spinner, San Francisco–Oakland Bay Bridge (Res., 2136 California St.), San Francisco, Calif.

Kantor, Nathan (Jun. '35), Care, Dept. of Agriculture, SCS, Photogrammetric Div., Washington, D.C.

Kenlon, John Fennell (Jun. '35), 2532 Creston Ave., New York, N.Y.

Kindsvater, Carl Edward (Jun. '35), 328 South Governor St., Iowa City, Iowa.

King, Russell Earle (Jun. '35), Clemson, S.C.

King, Walter Winburne, Jr. (Jun. '35), 502 Church St., Greensboro, N.C.

Klein, Francis Burt (Jun. '35), 6719 Chamberlain Ave., University City, Mo.

Krasnodebski, Casimir (Jun. '35), 245 Twelfth St., Brooklyn, N.Y.

Lawrence, Fred Forrest (Jun. '35), Care, State Highway Dept., Box 54, Ritzville (Res., 1505 North Alder St., Tacoma), Wash.

LeDoux, Joseph McLean (Assoc. M. '35), Asst. Engr., Drainage Dept., Sewerage and Water Board of New Orleans (Res., 1219 Pine St.,) New Orleans, La.

Leisch, Jack Eugene (Jun. '35), 817 Lake Drive, Baltimore, Md.

TOTAL MEMBERSHIP AS OF JANUARY 9, 1936

Members	5,714
Associate Members	6,120
Corporate Members	11,834
Honorary Members	21
Juniors	3,141
Affiliates	93
Fellows	2
Total	15,091

Levy, Albert MacCullough (Jun. '35), 1153 Wenonah Ave., Oak Park, Ill.

Lippis, Rocco Louis (Jun. '35), 9670 Fifty-Fourth Ave., South, Seattle, Wash.

Lundheim, Erling Jacob (Jun. '35), 419 East 18th St., Minneapolis, Minn.

McCray, Lionel Grant (Jun. '35), Surv., U. S. Forest Service, Fort Defiance (Res., St. Michaels), Ariz.

McNair, James Elbredge (Jun. '35), 1102 Whaley St., Columbia, S.C.

McRae, Robert Alexander (Jun. '35), Instrumentman, Pacific Elec. Ry. (Res., 2139 South Cloverdale Ave.), Los Angeles, Calif.

Marxen, Paul Berthold (Jun. '35), With Am. Bridge Co. (Res., 2136 California St.), San Francisco, Calif.

Mathewson, Charles Ellis, Jr. (Jun. '35), 2622 Grand Ave., New York, N.Y.

Meads, John Herbert (Jun. '35), 154 Twelfth St., S.E., Washington, D.C.

Mendenhall, John Dale (Jun. '35), Concrete Insp., Met. Water Dist. of Southern California, Box 487, Van Nuys, Calif.

Mendes, Frank Harold (Assoc. M. '35), Chf. Draftsman, Empire City Subway Co. Ltd., 138 Spring St., New York, N.Y.

Michener, John Henry, Jr. (Jun. '35), 131 Fifth St., Bridgeport, Pa.

Moore, Guy William (Jun. '35), 314 Bedford Ave., Buffalo, N.Y.

Morgan, Elmo Rich (Jun. '35), Room 403, State Capitol Bldg., Salt Lake City, Utah.

Mullaney, Howard Joseph (Jun. '35), 246 Robinson Ave., New York, N.Y.

Nagel, Henry Peter, III (Jun. '35), 674 Franklin St., Denver, Colo.

Nawrocki, William John (Jun. '35), 206 Myrtle Ave., Jersey City, N.J.

Neubecker, Lincoln Carl (Jun. '35), 1374 Giel Ave., Lakewood, Ohio.

Niday, Lloyd Edward (Jun. '35), 635 Third Ave., Gallipolis, Ohio.

Nielsen, Hans Eugene (Jun. '35), Junior Erosion Specialist, Eugene J. Carpenter, Box 301, Safford, Ariz.

Oppenheim, James Randolph (Jun. '35), Box 236, Winnsboro, Tex.

Owley, Arthur Norman (Jun. '35), 5249 Mayflower St., Seattle, Wash.

Peterson, Arthur Vincent (Jun. '35), 201 William St., Ithaca, N.Y.

Peterson, Dean Freeman, Jr., (Jun. '35), Junior Engr., WPA for Utah, 45 West 2d. South, Provo, Utah.

Post, Carl Arthur (Jun. '35), 526 Fifth St., Ames, Iowa.

Powell Waldo Stanislaus, Jr. (Jun. '35), 8138 Cohn St., New Orleans, La.

Quinn, James Bernard (Jun. '35), Box 344, Balboa Heights, Canal Zone.

Richards, Frederick Tracy (Jun. '35), Box 825, Lawrenceville, N.J.

Ruddy, John William (Jun. '35), 310 East Market St., Wilkes-Barre, Pa.

Schenkelbach, Abraham (Jun. '35), 2343 Morris Ave., New York, N.Y.

Schlitt, Henry George (Assoc. M. '35), Asst. Bridge Engr., State Dept. of Roads and Irrig. (Res., 4233 Orchard St.), Lincoln, Nebr.

Schulz, Walter George (Jun. '35), 842 Forty-Seventh Ave., San Francisco, Calif.

Seeboth, Albert Joseph (Jun. '35), Under Eng. Aide, U. S. Dept. of Agriculture, Bureau of Biological Survey; Allenton, Wis.

Shaw, Virgil Eugene (Jun. '35), Care, Louisville Cement Co., 315 Guthrie St., Louisville, Ky.

Shelley, Sidney (Jun. '35), 830 East 24th St., Paterson, N.J.

Simon, William John (Jun. '35), 425 South Kingsley Drive, Los Angeles, Calif.

Smallshaw, James (Assoc. M. '35), Asst. Hydr. Engr., TVA, Box 62, Murphy, N.C.

Smith, Herman Sidwell (Jun. '35), Draftsman, Water Resources Div., State Planning Board, 410½ Pine St., Muscatine, Iowa.

Smith, Kenneth Alan (Jun. '35), With Am. Bridge Co. (Res., 2136 California St.), San Francisco, Calif.

Sollenberger, Norman John (Jun. '35), 818 Bertrand St., Manhattan, Kans.

Swift, Dean Edwin (Jun. '35), Olathe, Kans.

Taylor, John Robert, Jr., (Jun. '35), 1736 Eugene, Dallas, Tex.

Teall, Lewis Whitney (Jun. '35), Care, SCS 10, Farlington, Kans.

Vander Velde, Theodore Louis (Jun. '35), 700 Franklin St., S.E., Grand Rapids, Mich.

Wagner, Edward Platt (Jun. '35), 55 West 42d St., New York, N.Y.

Walker, William Powell (Jun. '35), Box 6, Claverack, N.Y.

Wamstad, Charles Oscar (Jun. '35), Concrete Insp., U. S. Bureau of Reclamation, Parma, Idaho.

Watson, Joseph Sherwood (M. '35), Asst. Engr., Sewer Dept., City of Columbus (Res., 998 McAllister Ave.), Columbus, Ohio.

Westra, George David (Assoc. M. '35), Engr., Elmira Light, Heat & Power Corporation (Res., 929 Grove St.), Elmira, N.Y.

Williams, Sam S. (Jun. '35), 1125 Termon Ave., N.S., Pittsburgh, Pa.

Membership Transfers

Alperin, Max (Jun. '29; Assoc. M. '35), Asst. Engr., Dept. of Finance, City of New York, Room 631, Municipal Bldg., New York, N.Y.

Babb, Arnold Obed (Jun. '30; Assoc. M. '35), Asst. Engr., Frederick Snare Corporation, Grafton (Res., Keyser), W. Va.

Brinhauer, Frank Hugh (Jun. '28; Assoc. M. '35), Engr. Examiner, PWA, 407 New Federal Court Bldg. (Res., 4418 University Ave.), Des Moines, Iowa.

Borton, Homer Thompson (Jun. '27; Assoc. M. '35), Asst. Civ. Engr., Grade Crossing Dept., City of Cleveland, 618 City Hall (Res., 14015 Glenside Rd.), Cleveland, Ohio.

Davidson, Edward Willoughby, Jr. (Jun. '27; Assoc. M. '35), Asst. Structural Engr., Puget Sound Navy Yard (Res., 2115 Sixth St.), Bremerton, Wash.

Gates, Howard Babcock, Jr. (Jun. '29; Assoc. M. '35), Engr., Robert W. Hunt Co., 34–40 Ludgate Hill, London, E. C. 4, England.

Kang, Shih-Cheng (Jun. '23; Assoc. M. '27; M. '35), Acting Vice-Director, Bureau of Public Roads, National Economic Council of China, Nanking, China.

Kuan, Fu Chuan (Jun. '31; Assoc. M. '35), Chf. Engr. of Waterways, Provincial Govt. of Kiangsu; Prof., Hydr. Eng., Coll. of Eng., National Central Univ., Nanking, China.

Li, Shu-T'ien (Jun. '26; Assoc. M. '32; M. '35), Pres., National Pei Yang Univ.; Director, Eng. Research Inst. (Res., 10 Oxford Villa (Niu Tsin Peu Shu), Oxford Rd., British Concession), Tientsin, China.

Mannerow, Carl Edward (Jun. '28; Assoc. M. '35), Asst. Engr., State Highway Dept. (Res., 612 First St.), Bismarck, N.Dak.

Miedwig, Andrew (Assoc. M. '20; M. '35), Superv. Engr., Day & Zimmermann Eng. & Constr. Co., Philadelphia, Pa.

Miller, Leroy Glick (Jun. '27; Assoc. M. '35), Dist. Plant Chf., New York Telephone Co. (Res., 114 Morningside Drive), Elmira, N.Y.

Myers, Walter Dow (Jun. '28; Assoc. M. '35), Asst. Engr., Safe Harbor Water Power Corporation and Pennsylvania Water & Power Co., 1512 Lexington Bldg., Baltimore, Md.

Pou, Frank Eugene Stanton (Jun. '27; Assoc. M. '35), Bridge Insp., State Highway Dept., Mount Hebron, Ala.

Radcliffe, Donald Verne (Jun. '27; Assoc. M. '35), 3620 Lewis Ave., Long Beach, Calif.

Rayburn, Elbert Brevard, Jr. (Jun. '29; Assoc. M. '35), Engr., Ready Mixed Concrete Corporation (Res., 1100 Burdsal Parkway Boulevard), Indianapolis, Ind.

Swisher, Mark (Assoc. M. '25; M. '34), Contr. and Industrial Engr., 1718 Lakefront Ave., Cleveland, Ohio.

Reinstatements

Fowler, Charles Evan, M., reinstated Jan. 7, 1936.

Graham, Harry Edward, Jun., reinstated Jan. 2, 1936.

Hefling, Arthur William, Assoc. M., reinstated Dec. 19, 1935.

Huebner, John Brady, Jun., reinstated Jan. 2, 1936.

Lane, Spencer Bridgman, Assoc. M., reinstated Jan. 2, 1936.

Lenert, Louva Gerhard, M., reinstated Nov. 18, 1935.

Porter, Robert Marvin, Assoc. M., reinstated Jan. 6, 1936.

Principe, Osvaldo José de Calasanz, Jun., reinstated Jan. 6, 1936.

Rosenberger, Raymond Joyce, Assoc. M., reinstated Jan. 2, 1936.

Sethmann, Martin William, Jun., reinstated Dec. 11, 1935.

Stern, Mitchel, Jun., reinstated Jan. 2, 1936.

Thompson, Isadore, Jun., reinstated Jan. 2, 1936.

Toomey, Thomas Jeremiah, Jr., Jun., reinstated Jan. 2, 1936.

Trax, George Percival, Assoc. M., reinstated Jan. 2, 1936.

Vania, Francis Harold, Jun., reinstated Jan. 2, 1936.

Williams, Cecil Calvert, M., reinstated Jan. 2, 1936.

Resignations

Barbarin, Marco Parker, Jun., resigned Dec. 13, 1935.

Barker, James Madison, Assoc. M., resigned Dec. 31, 1935.

Barton, William Henry, Jr., M., resigned Dec. 26, 1935.

Batham, William Stanley, M., resigned Dec. 31, 1935.

Bauer, Charles Henry, Jr., Jun., resigned Dec. 13, 1935.

Black, Clarence Neelly, M., resigned Dec. 13, 1935.

Boyle, John Joseph, Jun., resigned Dec. 31, 1935.

Bridgham, Minot Robert Sherman, Jun., resigned Dec. 12, 1935.

Cadman, Charles Keeney, M., resigned Jan. 2, 1936.

Cleary, Charles Norman, Assoc. M., resigned Dec. 26, 1935.

Cooper, John Edward, Affiliate, resigned Dec. 26, 1935.

Crawford, Charles John, M., resigned Dec. 13, 1935.

Crocker, Calvin Ira, M., resigned Dec. 20, 1935.

Dabb, Albert Henry, Jr., Jun., resigned Dec. 31, 1935.

Daudt, Carl Fabian, Jun., resigned Dec. 26, 1935.

Delano, Edward Rawlings, Jun., resigned Dec. 19, 1935.

Ellis, Herbert Cram, Assoc. M., resigned Dec. 31, 1935.

Fairtrace, George DeVore, Assoc. M., resigned Dec. 31, 1935.

Garner, Chester Arthur, Assoc. M., resigned Dec. 10, 1935.

Geldert, Leonard Dunbar, Assoc. M., resigned Dec. 31, 1935.

Geupel, Carl Martin, Assoc. M., resigned Dec. 11, 1935.

Givens, Harrison Crandall, Jr., Jun., resigned Dec. 31, 1935.

Harrop, James Lawrence, Assoc. M., resigned Dec. 31, 1935.

Haskell, Nelson Burritt, Jun., resigned Dec. 12, 1935.

Heavey, William Francis, M., resigned Dec. 31, 1935.

Hellmich, Walter Frederick, Jun., rerigned Dec. 11, 1935.

Holman, Edwin Asa, Jun., resigned Dec. 10, 1935.

Jacobson, Joel Martin, Jun., resigned Dec. 27, 1935.

Johnston, Harry Vester, M., resigned Dec. 30, 1935.

Kes, Anthony, Jr., Jun., resigned Dec. 31, 1935.

Koeberle, Harold, Jun., resigned Dec. 31, 1935.

Lamson, William Mather, Assoc. M., resigned Dec. 19, 1935.

Lind, Sebastian Henry, Jr., Jun., resigned Dec. 27, 1935.

Lodge, John, Assoc. M., resigned Jan. 4, 1936.

McKinstry, Ross Waldron, Assoc. M., resigned Dec. 14, 1935.

Manson, Egbert Farrand, M., resigned Dec. 31, 1935.

Neer, Don Morgan, Assoc. M., resigned Jan. 2, 1936.

Nelson, George Alvin, Jun., resigned Dec. 31, 1935.

Owen, Samuel Patterson, Jun., resigned Dec. 31, 1935.

Parker, Edwin Stone, Assoc. M., resigned Jan. 7, 1936.

Philips, Hector Somerville, M., resigned Dec. 31, 1935.

Rabello, Cesar de Sa, M., resigned Dec. 31, 1935.

Rumble, George Bertyl, Assoc. M., resigned Dec. 11, 1935.

Schuerman, William Augustus, Assoc. M., resigned Dec. 31, 1935.

Shute, James Selden, M., resigned Dec. 26, 1935.

Talmadge, Ezra Edwin, M., resigned Jan. 7, 1936.

Terry, Francis Hallock, Jun., resigned Dec. 31. 1935.

Thomas, James Henry, Assoc. M., resigned Dec. 31, 1935.

Van Duyne, Richard, Assoc. M., resigned Dec. 20, 1935.

Warren, Herbert Anson, Assoc. M., resigned Dec. 31, 1935.

Whitsit, Lawrence Cousins, Jun., resigned Dec. 31, 1935.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

February 1, 1936 NUMBER 2

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

Ahrenholz, Kenneth Richard, Brooklyn, N.Y. (Age 23.) Graduate student, Brooklyn Polytechnic Inst. Refers to D. C. A. du Plantier, S. C. Houser.

Baughn, Charles Weaver, Little Rock, Ark. (Age 23.) Draftsman, Arkansas State Highway Comm. Refers to N. B. Garver, M. W. Kehart, W. R. Spencer.

Besse, Irvin Kent, Worchester, Mass. (Age 23.) Refers to P. S. Dow, R. Fletcher, F. W. Garran, C. A. Holden, R. R. Marsden.

Boggs, Allen Claude, South Bend, Ind. (Age 51.) Constr. Supt. and Civ. Engr., Standard Oil Co. Refers to F. E. Brown, J. D'Esposito, W. L. R Haines, J. G. Kenan, W. A. Knapp, G. E. Lommel, D. Y. Swaty.

Braisted, William Adelbert, Bennington, Vt. (Age 33.) Village Engr. and Street Commr. Refers to H. B. Compton, W. A. Hawks, T. R. Lawson, H. O. Sharp, G. R. Solomon.

Brown, Stanley Montgomery, Bismarck, N.Dak. (Age 33.) State Maintenance Engr., North Dakota State Highway Dept. Refers to J. M. Brown, H. E. Fowler, E. R. Griffin, G. E. Hanson, C. Johnson.

Buren, Clarence Willard, Chicago, Ill. (Age 24.) Refers to J. G. Bennett, T. L. Condron, F. G. Gordon, A. J. Hammond, G. B. Massey.

Cantrell, Lorraine Vivian, Berkeley, Calif. (Age 43.) Asst. State Steel Inspector, San Francisco–Oakland Bay Bridge San Francisco, Calif. Refers to C. E. Andrew, H. A. Betaque, F. W. Karge, R. J. Reed, H. G. Sharp.

Carrico, Edmondson Ewing, Louisville, Ky. (Age 22.) Rodman, Commrs. of Sewerage. Refers to R. E. Hutchins, R. L. McCormick.

Darnall, William Henry, Jr., Princeton, W.Va. (Age 26.) Inspector, State Road Comm. of West Virginia. Refers to E. C. Barton, E. M. Brown, C. P. Fortney, J. K. McGrath, M. W. Smith, Jr.

Devlin. Harry Kerchever, Brooklyn, N.Y. (Age 44.) Estimator with Gibbs & Hill, Cons. Engrs., New York City. Refers to E. H. Anson, D. Y. Dimon, A. D. Fields, E. R. Hill, C. C. Kohlheyer.

Eberhart, Howard Davis, Portland, Ore. (Age 29.) Prin. Draftsman with U. S. Army Engrs., Bonneville Dam Sec. Refers to H. F. Blood, J. R. Griffith, C. I. Grimm, H. H. Hodgeson, F. Merryfield, C. A. Mockmore.

Elder, John William, Kansas City, Mo. (Age 27.) Engr., E. T. Archer & Co., Cons. Engrs. Refers to E. Boyce, J. O. Jones, F. A. Russell.

Esteves-Volckers, Rene, San Juan, Puerto Rico. (Age 32.) Constr. Engr., Acting Dist. Mgr., Housing Div., FEA of PW, Dist. Office, San Juan. Refers to J. Benitez-Gautier, M. Font, F. Fortuno-Selles, H. I. Hettinger, J. D. Morales, R. Skerrett-Landron.

Farrell, Joseph Romulus, Philadelphia, Pa. (Age 40.) Engr. and Contr. Refers to H. C. Berry, W. L. Butler, E. L. Davis, E. T. Grandlienard, J. J. Grelis, Jr., B. F. Hastings, S. H. Knight, L. L. Lessig, W. S. Pardoe, E. L. Shoemaker, W. Steinbruch.

Groner, David, Watkins Glen, N.Y. (Age 22.) Senior Foreman, CCC Camp, under Finger Lakes State Parks Comm., S.P. No. 44. Refers to F. A. Barnes, A. A. K. Booth, C. Crandall, J. E. Perry, L. C. Urquhart.

Harris, Millard Henry, Chattanooga, Tenn. (Age 29.) Chf. of Party with U. S. Geological Survey. Refers to C. H. Birdseye, T. P. Pendleton, J. G. Staack, C. A. Walkwitz, R. M. Wilson, E. M. Woods.

Jenkins, Edward Magill, Somerville, N.J. (Age 38.) Research Engr., Johns-Manville Research Laboratories, Manville, N.J. Refers to W. C. Brockway, H. L. Rogers, C. O. Skinner, C. H. Sutherland, W. C. Voss.

Kruse, Cornelius Wolfram, Decatur, Ala. (Age 22.) Under Sen. Engr., TVA, Health and Sanitation Sec., Iuka, Miss. Refers to C. E. S. Bardsley, J. B. Butler, E. W. Carlton, E. G. Harris, W. G. Stromquist.

Laurgaard, Glenn Olaf, Yuma, Ariz. (Age 23.) Laboratory Asst., U. S. Bureau of Reclamation, All American Canal. Refers to R. B. Hammond, H. F. Janda, J. L. Savage, J. C. Stevens, L. F. Van Hagan.

Lemcke, Karl Wolfgang, Flushing, N.Y. (Age 49.) Designer and Detailer, New York Central R.R., New York City. Refers to H. C. Baird, S. W. Bradshaw, D. G. Edwards, S. Hardesty, F. A. Rossell, Z. H. Sikes, J. R. Smith, D. B. Steinman, J. A. L. Waddell.

Lyons, Percy Felix, Dallas, Tex. (Age 49.) Examiner, WPA, Dist. 4. Refers to E. Couch, F. D. Hughes, O. H. Koch, N. E. Lant, J. T. L. McNew, E. L. Myers, E. N. Noyes, G. G. Wickline.

MacDougall, Robert Leak, Atlanta, Ga. (Age 34.) In complete charge of work program of various agencies operating under FERA, CWA and WPA. Refers to L. F. Bellinger, F. H. Frasuer, R. V. Glenn, S. Gordy, W. A. Hansell, R. G. Hicklin, F. H. McDonald, M. T. Singleton.

MacNaughton, George Douglas, East Orange, N.J. (Age 33.) Asst. Civ. Engr., acting as Chf. of Party, Plans and Surveys Div., New Jersey State Highway Dept. Refers to R. M. Beck, F. L. Cranford, J. L. Davis, H. S. DeGroodt, H. R. Gabriel, M. W. Grimes, S. Johannesson.

McCain, John Irving, Jr., Colfax, La. (Age 27.) Jun. Engr., Soil Conservation Service Minden, La. Refers to J. R. Blondin, C. D. Gibson, F. C. Snow.

McCann, Eugene Harrison, Jr., Houston, Tex. (Age 22.) Jun. Engr., Humble Oil & Refining Co. Refers to J. S. Fenner, J. J. Richey.

Malony, Walden LeRoy, Pullman, Wash. (Age 52.) Superv. Engr., State College of Washington. Refers to A. D. Butler, T. H. Judd, M. Macartney, W. A. Rogers, D. H. Sawyer, M. R. Snyder, C. C. Wright.

Miller, Arthur Patterson, West Englewood, N.J. (Age 39.) San. Engr., U. S. Public Health Service, New York City. Refers to L. H. Enslow, P. Hansen, R. L. Sackett, T. Saville, A. Wolman.

Miller, John Henry, Jr., Baltimore, Md. (Age 40.) Pres., J. Henry Miller, Inc. Refers to H. F. Doeleman, A. H. Krone, H. G. Perring, V. R. P. Saxe, C. A. Weiller.

Molstad, Reginald, New York City. (Age 56.) Supervising Engr., Inspection Div., FEA of PW. Refers to F. S. Crowell, H. J. Deutschbein, J. W. Doty, G. L. Freeman, M. E. Gilmore, C. E. Trout.

Momchiloff, Momchil Stephen, New York City. (Age 31.) Refers to E. H. Sargent, J. A. Van den Broek.

Quenneville, Raymond Joseph, Holyoke, Mass. (Age 21.) Refers to A. W. French, J. W. Howe, A. J. Knight, C. F. Meyer.

Ramage, Harry Lawrence, Allentown, Pa. (Age 42.) Chf. Engr. and Director, The Tilghman Moyer Co. Refers to B. C. Collier, C. de Moll, R. L. Fox, J. J. Grelis, Jr., L. Hart, T. H. Moyer, J. F. Murray, E. E. Seyfert, C. M. Vetter, J. J. Vogdes.

Reed, Rex Raymond, Denver, Colo. (Age 25.) Jun. Engr., U. S. Bureau of Reclamation, Canals Div. Refers to C. R. Burky, C. E. Mickey, N. T. Olson, A. B. Reeves, R. Sailer, C. P. P. Vetter.

Retief, Everhardus Malherbe, East London, South Africa. (Age 31.) Asst. Engr. with South African Rys. Refers to D. F. Marais, H. A. Smith, W. G. Sutton, R. J. van Reenen, C. V. von Abo.

Rittgers, Virden Acie, Oklahoma City, Okla. (Age 33.) Office Engr., City Eng. Dept. Refers to E. B. Black, J. F. Brookes, C. A. Bullen, L. M. Bush, F. Herrmann, V. V. Long, H. W. Nighswonger, G. B. Treat, D. L. Wilson, N. E. Wolfard.

Robinson, Camm Paul, Johannesburg, South Africa. (Age 36.) Eng. Asst., Rand Water Board. Refers to T. Breslin, W. G. Sutton, C. V. von Abo. (Applies in accordance with Sec. 1, Art. I, of the By-Laws.)

Schmidt, Hugh Henry, Lincoln, Nebr. (Age 23.) Draftsman, State Bureau of Roads & Irrigation. Refers to C. M. Duff, M. I. Evinger, H. J. Kesner, J. G. Mason, C. E. Mickey.

Shultz, Robert John, Chattanooga, Tenn. (Age 28.) Eng. Draftsman, TVA. Refers to H. H. Hodgeson, T. P. Pendleton, E. M. Woods.

Simpson, Walter Linton, Washington, D.C. (Age 47.) Senior Regional Engr., Resettlement Administration. Refers to T. C. Atwood, N. W. Dougherty, P. A. Fellows, W. A. Hitchcock, J. H. Pratt, R. R. Pyne.

Smith, Ezekiel Jackson, Macon, Ga. (Age 45.) Div. Engr., Georgia State Highway Dept. Refers to W. R. Neel, C. C. Newsom, C. L. Rhodes, E. N. Seymour, W. A. Young.

Smith, Richard Albert, Madison, Wis. (Age 33.) Asst. Chf. Engr., Dist. Line Supervisor, Dist. No. 6, WPA of Wisconsin. Refers to W. D. Beisell, A. L. Hambrecht, H. F. Janda, H. J. Kuelling, H. W. Mead, M. W. Torkelson, C. N. Ward.

Starr, William Lawrence, Lufkin, Tex. (Age 29). Chf. Draftsman with Texas State Highway Dept. Refers to T. E. Huffman, C. H. Kendall, V. G. Koch, L. C. Miller, S. W. Mims.

Sundaresan, Trichinopoly Visvanatha Iyer, Ernakulam, South India. (Age 38.) Draftsman (Designer) with C. W. Knight, Executive Engr., Cochin Harbor Works. Refers to J. R. Colobawala, U. S. Jayaswal. (Applies in accordance with Sec. 1, Art. I, of the By-Laws.)

Taylor, Henry William, New York City. (Age 55.) Cons. Engr. Refers to E. S. Chase, C. A. Emerson, Jr., E. A. Fisher, C. G. Hyde, H. E. Moses, J. F. Skinner, E. L. Waterman.

Taylor, Thomas Frederic, Pickwick Dam, Tenn. (Age 32.) Asst. Field Engr., TVA, at Pickwick Landing Dam. Refers to K. V. Jones, J. S. Lewis, Jr., A. L. Pauls, O. Reed, R. White, C. P. Wright.

Vaccaro, George, Brooklyn, N.Y. (Age 28.) Draftsman with Madigan & Hyland, Cons. Engrs., New York City. Refers to F. De Schauensee, W. G. L. McFarland, E. J. Squire, B. L. Weiner, E. E. Wissotsky.

Vawter, Wallace Read, Ocala, Fla. (Age 33.) Civ. Engr., U. S. Engr. Office. Refers to C. E. Boesch, V. M. Cone, W. G. Grove, F. I. Louckes, G. W. Miller, C. H. Schwartz.

Von Halle, Millard Frank, Hackensack, N.J. (Age 25.) Refers to A. H. Beyer, J. K. Finch, L. H. Lockwood, W. S. Lohr, E. H. Rockwell.

Watts, William Ray, Tahoka, Tex. (Age 25.) Instrumentman, Texas Highway Dept. Refers to O. V. Adams, L. C. Ingram, Jr., J. H. Murdough, G. W. Parkhill.

Weidner, Charles Kenneth, Walla Walla, Wash. (Age 31.) Res. Engr. and Business Mgr. and Instructor in Applied Mechanics, Whitman Coll. Refers to T. D. Hunt, C. M. Jenkins, J. Kylstra, H. W. McCurdy, G. L. Youmans.

Werner, Max Alfred, Jr., Madison, Wis. (Age 25.) Field and Office Engr. with Mead, Ward & Hunt, Cons. Engrs. Refers to D. W. Mead, F. E. Turneaure.

Williams, Charles Harvey, Olympia, Wash. (Age 48.) City Engr. and Water Supt. Refers to C. E. Beam, R. L. Carter, E. M. Chandler, E. C. Dohm, H. J. Flagg, R. M. Gillis, E. L. Greene, H. M. Hadley, W. A. Kunigk, O. A. Piper, C. D. Pollock, W. F. Way.

Wilson, Harry Lantz, Minneapolis, Minn. (Age 45.) Prin. Asst. Project Engr., PWA, Minneapolis-St. Paul San. Dist. Project. Refers to F. S. Altman, F. Bass, W. N. Carey, A. P. Hustad, A. E. Lindau, L. H. Sault.

York, James Mooring, Lufkin, Tex. (Age 30.) Div. Office Engr., Div. No. 11, Texas State Highway Dept. Refers to T. W. Bailey, T. E. Huffman, V. G. Koch, C. W. McFerron, S. W. Mims.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

Cummings, Albert Edward, Assoc. M., Chicago, Ill. (Elected April 3, 1922.) (Age 41.) Dist Mgr., Raymond Concrete Pile Co. Refers to C. R. Gow, H. H. Hadsall, S. C. Hollister, A. R. Lord, W. V. McMenimen, M. M. Upson, L. F. Van Hagan.

Freese, Simon Wilke, Assoc. M., Fort Worth, Tex. (Elected Junior April 3, 1922; Assoc. M. June 7, 1926.) (Age 35.) Hawley, Freese & Nichols, Cons. Engrs.; San. Engr. for PWA Comm. Refers to J. H. Brillhart, J. B. Hawley, J. M. Howe, D. W. Mead, J. A. Norris, E. N. Noyes, C. M. Spofford.

Henning, Charles Sumner, Jr., Assoc. M., Abilene, Tex. (Elected Junior Dec. 3, 1913; Assoc. M. Dec. 6, 1915.) (Age 47.) Vice-Pres. and Gen. Mgr., Womack-Henning Constr. Co. Refers to J. C. Carpenter, C. M. Davis, G. Gilchrist, J. B. Hawley, A. P. Rollins, R. A. Thompson, G. G. Wickline.

Hubbard, Winfred Dean, Assoc. M., Kingston, N.Y. (Elected Nov. 5, 1902.) (Age 59.) Div. Engr. in charge of Catskill Croton Div., Dept. of Water Supply, Gas & Electricity, New York City. Refers to W. W. Brush, C. E. Davis, J. Goodman, G. G. Honness, J. S. Langthorn, H. S. R. McCurdy, R. N. Wheeler.

Knappen, Theodore Temple, Assoc. M., Zanesville, Ohio. (Elected Junior Jan. 16, 1928; Assoc. M. June 10, 1929.) (Age 35.) Chf., Eng. Div., Zanesville Dist., U. S. Engr. Office. Refers to A. L. Alin, C. C. Chambers, G. H. Friend, L. C. Hill, T. H. Jackson, J. D. Justin, B. B. Somervell.

Mittag, Albert Alfred, Assoc. M., Hoboken N.J. (Elected Junior June 7, 1926; Assoc. M. Nov. 11, 1929.) (Age 35.) Constr. Engr., Pan-American Airways, Guam. Refers to J. H. Caton, 3rd, M. E. Gilmore, G. L. Govin, R. W. Hebard, F. R. Molther, B. F. Vandervoort.

Neuman, David Leonard, Assoc. M., Richmond, Va. (Elected Junior Feb. 4, 1914; Assoc. M. Nov. 9, 1920.) (Age 44.) Asst. to Div. Engr., South Atlantic Div., U. S. Engrs. Refers to C. H. Brown, E. I. Brown, L. Brown, E. J. Dent, S. C. Godfrey, H. T. Immerman, T. M. Jasper.

Peck, John Sanford, Assoc. M., Scarsdale, N.Y. (Elected Junior Nov. 28, 1916; Assoc. M. Jan. 17, 1921.) (Age 42.) Asst. Prof. in charge Materials Testing Laboratory, School of Technology, Coll. of the City of New York. Refers to E. V. Barrett, A. H. Beyer, R. E. Goodwin, W. J. Krefeld, F. O. X. McLoughlin, J. C. Rathbun.

Roberts, Emory Douglas, Assoc. M., Milwaukee, Wis. (Elected Nov. 21, 1921.) (Age 36.) Prof. and Head of Dept. of Civ. Eng., Marquette Univ. Refers to J. L. Ferebee, A. E. Holcomb, S. M. Siesel, F. A. Torkelson, C. S. Whitney.

Stumpf, Edward Heer, Assoc. M., Pittsburgh, Pa. (Elected Oct. 26, 1931.) (Age 38.) Asst. Chf. Engr., Eastern Region, National Paving Brick Association. Refers to H. G. Appel, S. Eckels, W. W. C. Perkins, J. S. Ritchey, N. Schein, G. F. Schlesinger, G. W. Schusler, N. S. Sprague, P. M. Tebbs.

Walker, Eldred Herbert, Assoc. M., Rochester, N.Y. (Elected Oct. 1, 1926.) (Age 40.) Structural Engr. City Engr.'s Office, Rochester; at present loaned to Gordon & Kaelber as Supt. of Constr. Refers to H. W. Baker, E. A. Fisher, M. D. Hayes, I. E. Matthews, T. J. Morrison, C. A. Poole, L. M. Sanford, C. F. Starr, A. L. Vedder.

Weaver, Frank Lloyd, Assoc. M., Garrett Park, Md. (Elected Junior April 18, 1916; Assoc. M. July 6, 1920.) (Age 44.) Rate Engr., and Analyst, Electric Rate Survey, Federal Power Comm. Refers to L. E. Ayres, C. W. Hubbell, L. G. Lenhardt, H. E. Riggs, A. Roth, C. J. Tilden.

From the Grade of Junior

Bitner, Melville Sperry, Jun., Denver, Colo. (Elected Oct. 1, 1928.) (Age 31.) Progress Engr., Moffat Water Tunnel Project. Refers to E. J. Albrecht, H. S. Crocker, L. R. Douglass, C. L. Eckel, O. A. Seward, Jr., J. J. Woltmann.

Coon, Emmett John, Jun., Sacramento, Calif. (Elected Oct. 26, 1931.) (Age 32.) Asst. Topographic Engr., U. S. Geological Survey. Refers to R. T. Evans, R. H. Fifield, H. H. Hodgeson, R. R. Monbeck, C. N. Mortenson, D. H. Rutledge, F. A. Wuopio.

Fricke, Frederick John, Jun., Tucumcari, N. Mex. (Elected Oct. 14, 1929.) (Age 30.) Jun. Civ. Engr., U. S. Engr. Office. Refers to H. F. Blaney, A. H. Dunlap, O. A. Faris, E. H. Marks, J. A. Norris, R. B. Tinsley.

Funk, Louis, Jun., New York City. (Elected Nov. 23, 1931.) (Age 32.) Asst. Engr., Park Dept., New York City. Refers to W. F. Barck, E. J. Carrillo, G. W. Knight, W. G. Taylor, B. Wuth.

Gewertz, Moe William, Jun., Los Angeles, Calif. (Elected Feb. 10, 1930.) (Age 30.) Jun. Bridge Constr. Engr., California Div. of Highways, Bridge Dept. Refers to C. F. Calhoun, R. R. Martel, F. W. Panhorst, F. Thomas, P. R. Watson.

Norton, Robert Arthur, Jun., Clarinda, Iowa (Elected Oct. 1, 1928.) (Age 32.) Associate Agri. Engr., Soil Conservation Service, U. S. Dept. of Agriculture, Washington, D.C. Refers to Q. C. Ayres, W. C. Huntington, L. A. Jones, S. H. McCrory, C. E. Ramser, C. C. Williams.

Prior, Charles Henry, Jun., Fayetteville, Tenn. (Elected Jan. 26, 1931.) (Age 31.) Asst. Hgdr. Engr., U. S. Geological Survey being Res. Engr., Chattanooga Dist. Refers to D. M. Corbett, N. C. Grover, J. C. Hoyt, C. E. McCashin, C. G. Paulsen, J. L. Saunders.

Salmen, Clifford Ross, Jun., Ogden, Utah. (Elected Nov. 11, 1929.) (Age 32.) Asst. Highway Engr., U. S. Bureau of Public Roads. Refers to T. W. Allen, R. A. Brown, O. C. Lockhart, R. R. Mitchell, J. H. Young.

Thomas, Miles Harrison, Jun., Rock Island, Ill. (Elected Nov. 14, 1927.) (Age 32.) Jun. Engr., acting as Party Chf., U. S. Engr. Office. Refers to J. B. Bassett, D. P. Booth, J. J. Doland, F. Hendershot, C. A. Hopkins, W. C. Huntington.

Weil, Herbert Louis, Jun., Fort Peck, Mont. (Elected Jan. 18, 1926.) (Age 32.) Asst. Engr., U. S. Corps of Engrs., Fort Peck Dist. Refers to W. J. Emmons, F. N. Menefee, T. Merriman, R. L. Morrison, N. T. F. Stadtfeld.

Wyllie, George Fair, Jun., Durand, Mich. (Elected Nov. 14, 1927.) (Age 32.) Engr. with Shoecraft, Drury and McNamee. Refers to A. J. Decker, W. R. Drury, W. C. Hoad, R. L. McNamee, R. H. Sherlock, E. C. Shoecraft, C. O. Wisler.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1935 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

Construction

Construction Engineer; Assoc. M. Am. Soc. C.E.; 50; married; over 25 years varied experience, including highways, bridges, dams, railroads, sewers, concrete works, building construction. Expert on private residences and small houses. Available immediately. Salary and location open. D-4493.

Design

Civil Engineer; Assoc. M. Am. Soc. C.E.; licensed professional engineer, New York State; 35; married; A.B. (Fordham), B.S. in C.E. (Manhattan College); 9 years experience in engineering, including detailing structural steel and iron; designing, drafting, estimating, surveying, and supervising various types of construction. Desires clerical or engineering position one or more evenings a week. C-6554.

Executive

Civil Engineer; M. Am. Soc. C.E.; licensed engineer and land surveyor in New York and New Jersey; over 30 years experience in construction of steam and electric railways, bridges and viaducts, sewers, tunnels, and highways; familiar with compressed air work. B-1486.

Executive; M. Am. Soc. C.E.; consulting civil engineer; 55; married; A.B. and M.C.; 36 years experience; qualified for responsible supervision and management; private or public work; familiar with all types and phases of engineering activity; accustomed to handling special unique problems requiring large personnel; free for engagements; location, West Coast. A-2394.

Patent Attorney; Assoc. M. Am. Soc. C.E.; registered patent attorney, who is graduate engineer and member of bar, desires to make change, preferably by forming connection with a corporation to organize and manage its patent department. Has had several years experience with an outstanding patent law firm. Has had three years experience with corporation patent departments. B-1819.

Civil Engineer; Jun. Am. Soc. C.E.; college graduate; 9 years practical experience; limited commercial pilot's license. Desires work where engineering and flying may be combined. Also has knowledge of photography. D-2211.

Civil Engineer; M. Am. Soc. C.E.; 48; married; 20 years experience in design, location, and construction of highways, bridges, wharves, airports, drainage systems; 10 years in responsible charge of $13,000,000 construction program. Desires connection with industrial or utility corporation where business training and technical knowledge essential. D-4312.

Graduate Civil Engineering; Assoc. M. Am. Soc. C.E.; registered in two states; 13 years experience; desirous of making connections; 4 years in supervision and construction of concrete highways and bridges; 5 years in charge of preliminary surveys and plans for municipal improvements; 4 years as construction engineer on large industrial plants—installation of equipment and preliminary operations. D-1100.

Graduate Structural Engineer; M. Am. Soc. C.E.; New York, Illinois, and California license; 20 years with present associates. Structural designer, estimator, and supervising engineer in charge of designing and drafting offices for industrial plants and facilities; railway shops and terminal structures; power houses and substations; special structures. Available to go anywhere on short notice. D-4320.

Civil Engineer; M. Am. Soc. C.E.; 42; married; 25 years industrial work (bakeries, packing houses, etc.) as office manager, purchasing agent, general superintendent. Desires similar post with architectural engineer or industrial corporation, or as superintendent of public works or buildings in municipality of 100,000. Eastern seaboard. Would go to England or Canada (connections in both) as sales representative. D-932.

Engineer; M. Am. Soc. C.E.; 38; C.E., New York State professional engineer's license; design and construction of industrial or metallurgical plants. B-5715.

Civil Engineer; Jun. Am. Soc. C.E.; Tau Beta Pi graduate; civil service ratings; business sales engineering work; single; 29; healthy; responsible; competent senior draftsman; estimator; 3 years New Jersey State Highway Department; contract construction; administrative public work and service projects planner; social experience; occupational labor rates and field inspector. C-7279.

Managing Engineer; M. Am. Soc. C.E.; Pennsylvania state registration; connected with steel fabricating industry in Pittsburgh and Cleveland districts for past 20 years in supervision of engineering, estimating, sales, fabrication, and erection. Desires opportunity to connect with a promising organization. C-5095.

Manufacturing Executive and Construction Engineer; Assoc. M. Am. Soc. C.E.; 42; 5 years in construction, maintenance, and operation of oil refineries; 3 years in charge of design of metropolitan trunk sewers; 8 years in charge of design, manufacture, and sale of heavy steel plate fabrication and welded pressure vessels, including development of special welding procedures. C-2465.

Junior

Civil Engineer; Jun. Am. Soc. C.E.; 28; married; B.C.E., University of Minnesota, 1932; 1 year experience as chainman, rodman, and instrumentman on paving and sewer work; 8 months experience as inspector of paving and materials, and hydraulic dredging; $1^1/_2$ years experience on highway construction, and topographic and land surveying in charge of field party. Desires position with opportunity. D-4557.

Civil Engineer; Jun. Am. Soc. C.E.; 24; single; B.S. in C.E., 1933. Majored in structural engineering; 1 year experience on road construction surveying; 6 months experience on drafting and design of large transport; 4 months experience on bridge inspection. Desires position. Location immaterial. Available immediately. D-3554.

Civil Engineer; Jun. Am. Soc. C.E.; 30; married; B.S. in C.E. degree, 1932; 3 months surveying; 9 months concrete roads; 3 summers bridge and building (railroads); 1 year installation of frigidare equipment, including air conditioning. Desires opportunity in any branch of engineering. D-4462.

Civil Engineer; Jun. Am. Soc. C.E.; 25; single; B.S. C.E., University of Illinois; 6 months experience drafting and detailing reinforced concrete structures; 5 months railroad surveying; $1^1/_2$ months hydraulic experimental work; 1 year general field work; 7 months executive position in connection with government construction program. Desires connection private firm or municipality. Free to travel. D-3595.

Civil Engineer; Jun. Am. Soc. C.E.; 25; single; no experience. B.S. C.E. University of California, 1935. Desires position in any branch of civil engineering. Salary immaterial. Available immediately. Location preferred, Pacific Coast. D-4461-355-A-9-San Francisco.